

**TOSHIBA**

# **INSTRUCTIONS**

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**INSTALLATION - OPERATION - MAINTENANCE**

**JK Series Medium Voltage Controllers - Fixed Type  
7.2kV Maximum**



**READ THIS MANUAL** carefully for important information about safety, handling, and maintenance for general-purpose NEMA Class E magnetic controllers.

This manual and all accompanying drawings should be considered a permanent part of the equipment. They should be readily available for review and reference at all times.

**DIMENSIONS** shown in the manual are in metric and/or their English equivalent.

These instructions are not intended to cover all details, combinations, or variations of the equipment, storage, or installation.

**PROBLEMS OR QUESTIONS** should be addressed to:

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13131 West Little York Road  
Houston, Texas 77041 USA  
Telephone: (713) 466-0277  
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FAX: (713) 466-8773



Use only Toshiba-authorized replacement parts.



This equipment is designed and built in accordance with applicable safety standards in effect on the date of manufacture. Unauthorized modifications can result in voiding the warranty, severe injury, death and property damage. Do not make any modifications to this equipment without the written approval of Toshiba.



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# TABLE OF CONTENTS

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Page ii

	Page
<b>SAFETY .....</b>	<b>1</b>
<b>RECEIVING AND HANDLING .....</b>	<b>4</b>
Receiving and Unpacking .....	4
Handling and Moving .....	4
Using a Forklift .....	5
Overhead Lifting .....	5
<b>STORAGE .....</b>	<b>6</b>
Preparation .....	6
Indoor Equipment .....	6
Outdoor Equipment .....	6
Routine Inspection .....	7
<b>GENERAL DESCRIPTION .....</b>	<b>8</b>
Construction .....	8
Controller Compartment .....	9
Isolation Switch .....	9
Vacuum Contactor .....	10
Outgoing Load Connections .....	11
Control Power Transformer .....	12
Operating Handle .....	13
Interlocks - Mechanical .....	13
Door Interlock .....	13
Handle Interlock .....	14
Vacuum Contactor Interlock .....	14
Interlocks - Electrical .....	15
Control Power Interlock (CPI) .....	15
Test Power Interlock (TPI) .....	15
Low Voltage Compartment .....	16
Main Bus Compartment .....	17
Prepared Spaces .....	17
Contactor Ratings .....	18
Controller Ratings .....	19
Horsepower Table .....	20
<b>INSTALLATION .....</b>	<b>21</b>
Rating Verification .....	21
Location .....	21
Service Conditions .....	21
Installation Site Preparation .....	22
Mounting .....	22
Grounding .....	23
Connections .....	25
Incoming Line .....	27



	Page
Outgoing Load .....	27
Power Fuse Cartridges.....	28
<b>PRE-ENERGIZATION CHECK.....</b>	<b>29</b>
General .....	29
Wiring .....	30
Devices / Mechanisms.....	31
Electrical Checks .....	32
<b>OPERATION .....</b>	<b>33</b>
Initial Energization.....	33
<b>MAINTENANCE .....</b>	<b>34</b>
Maintenance Record.....	34
General Inspection .....	35
Electrical Joints .....	36
Power Fuses .....	36
Vacuum Contactor.....	37
Isolation Switch.....	37
Switch Handle Mechanism.....	38
Interlocks.....	39
Control Power Transformer .....	40
<b>MAINTENANCE AFTER A FAULT CONDITION.....</b>	<b>41</b>
Enclosure .....	41
Isolation Switch.....	41
Power Fuse Cartridge .....	41
Terminals and Internal Conductors .....	41
Overload Relays.....	41
Vacuum Contactor.....	41
Return to Service.....	41
<b>WARRANTY AND LIMITATION OF LIABILITY .....</b>	<b>42</b>



## IMPORTANT MESSAGES

**Read this manual and follow its instructions.** Signal words such as DANGER, WARNING and CAUTION will be followed by important safety information that must be carefully reviewed.

### **DANGER**

Indicates a situation which will result in death, serious injury, and severe property damage if you do not follow instructions.

### **WARNING**

Means that you might be seriously injured or killed if you do not follow instructions. Severe property damage might also occur.

### **CAUTION**

Means that you might be injured if you do not follow instructions. Equipment damage might also occur.

**NOTE** Gives you helpful information

## READ SAFETY SIGNS

To avoid injury, you must read and follow all safety signs.

Keep the safety signs visible and in good shape. Never remove or cover any safety signs.



**QUALIFIED OPERATORS ONLY**

Only qualified persons are to install, operate, or service this equipment according to all applicable codes and established safety practices.

**A qualified person must:**

- 1) **Carefully read the entire instruction manual.**
- 2) Be skilled in the installation, construction or operation of the equipment and aware of the hazards involved.
- 3) Be trained and authorized to safely energize, deenergize, clear, ground, lockout and tag circuits in accordance with established safety practice.
- 4) Be trained and authorized to perform the service, maintenance or repair of this equipment.
- 5) Be trained in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses, face shield, flash clothing, etc. in accordance with established practices.
- 6) Be trained in rendering first aid.

**SAFETY CODES**

Toshiba medium voltage controllers are general purpose, Class E, magnetic controllers designed and built in accordance with the latest applicable provisions of NEMA ICS 3, Part 2 (ICS 2-324), UL 347 and the National Electrical Code. Installations must comply with all applicable state and local codes, adhere to all applicable National Electric Code (NFPA 70) standards and instructions provided in this manual.



**⚠ DANGER** HAZARDOUS VOLTAGE will cause severe injury, death, fire, explosion and property damage.

- Turn off and lock out Primary and Control Circuit Power before servicing.
- Do not open door unless Isolation Switch is OFF and Contactor is OPEN.
- Keep all panels and covers securely in place.
- Never Defeat, Modify, or Bypass any Safety Interlocks.
- Qualified Operators only.



**RECEIVING AND UNPACKING**

Upon receipt of the equipment, do the following:

- 1) Make an immediate inspection for any damage which might have occurred during shipment (Fig. 1). If damage is found, it should be noted with the carrier prior to accepting the shipment, if possible.
- 2) Carefully unpack the equipment sufficiently to check for concealed damage and to determine that the shipment is complete and correct.
- 3) Keep the equipment upright. If the controller is not upright upon receipt, notify the carrier of possible damage. Upright the unit as soon as possible.

**▲CAUTION** Do not lay the equipment on its side or upside down.

- 4) File a claim with the carrier for any damaged or missing item and immediately notify the nearest Toshiba Representative.

**▲WARNING** Do not install or energize equipment that has been damaged.

**HANDLING AND MOVING**

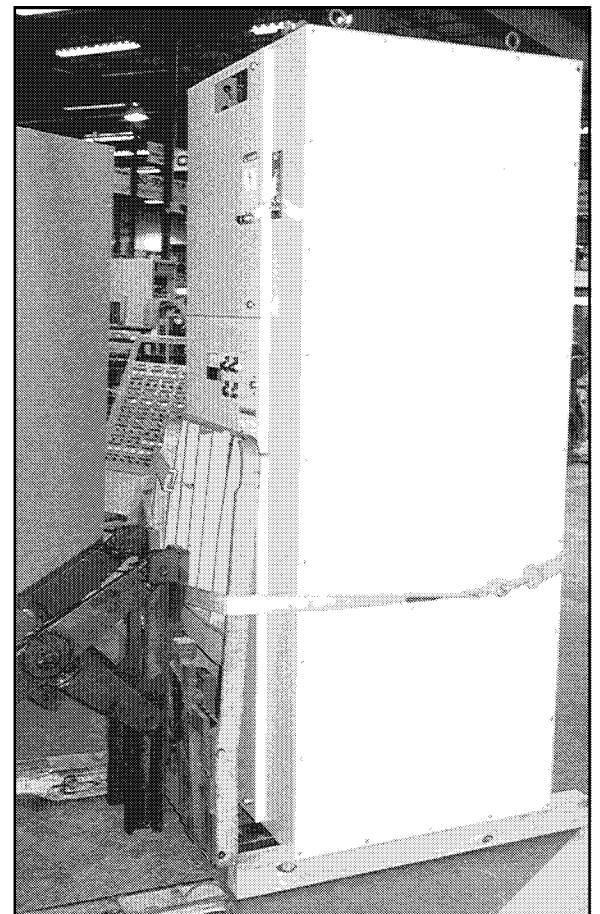
Medium voltage motor controllers should be handled with care, to avoid damage to components and to the frame or its finish (Fig. 2).

The capability of the moving equipment to handle the weight of the controller shipping section should be confirmed.

The equipment should remain secured to the shipping skid to prevent distortion of the frame during moving and to minimize tipping. Extreme care should be exercised during any



**Fig. 1 Inspect The Controller**



**Fig. 2 Moving The Controller**



movement and placement operations to prevent dropping, or tipping.

**⚠ WARNING**

**Do not place any part of your body beneath equipment being lifted. Improperly secured equipment can fall or tip over quickly and without notice.**

## USING A FORKLIFT

A forklift truck may offer a more convenient method of handling the controller. A safety strap should be used when handling with a forklift. The ends of the forks should not enter the bottom of an open-bottom enclosure.

## OVERHEAD LIFTING

When it is necessary to move the equipment between elevations, overhead hoisting may be required. Lifting angles (for multiple controller sections) are provided on top of the enclosure for this purpose.

Spreaders (Fig. 3) should be used to provide the vertical lift on single controllers to prevent eye-bolt failure.

Always keep the controller upright while lifting. Some controller sections may contain heavy or special equipment that will cause the center of gravity to be off-center. Rigging lengths should be adjusted to maintain the controller in an upright position. The angle between the lifting cables and vertical should not be allowed to exceed 45 degrees (Fig.4). Ropes or cables should not pass through the holes in lifting angles or eye-bolts. Slings with safety hooks or shackles of adequate load rating should be used.

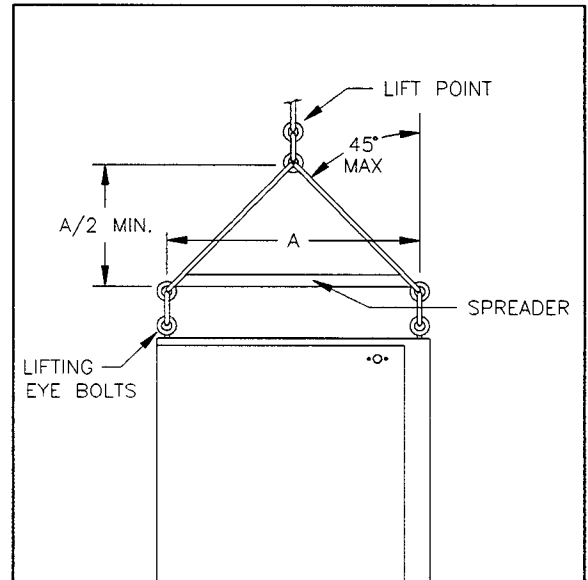


Fig. 3 Use of Spreader Bar - Single Section

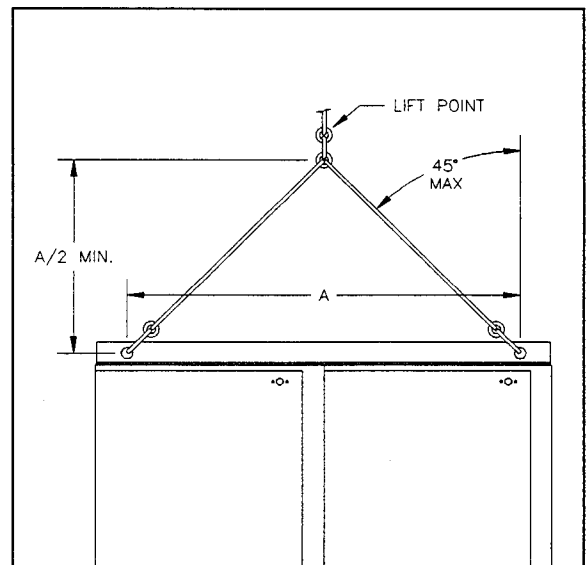


Fig. 4 Lifting Multiple Sections



**PREPARATION**

If the controller is to be stored for any length of time prior to installation, the packing should be restored for protection during that period. Where conditions permit, the packing should be left intact until the controller is at the final installation position. If the packing (Fig. 5) is removed, the top and openings of the controller should be covered during the construction period to protect it against dust and debris.

**INDOOR EQUIPMENT**

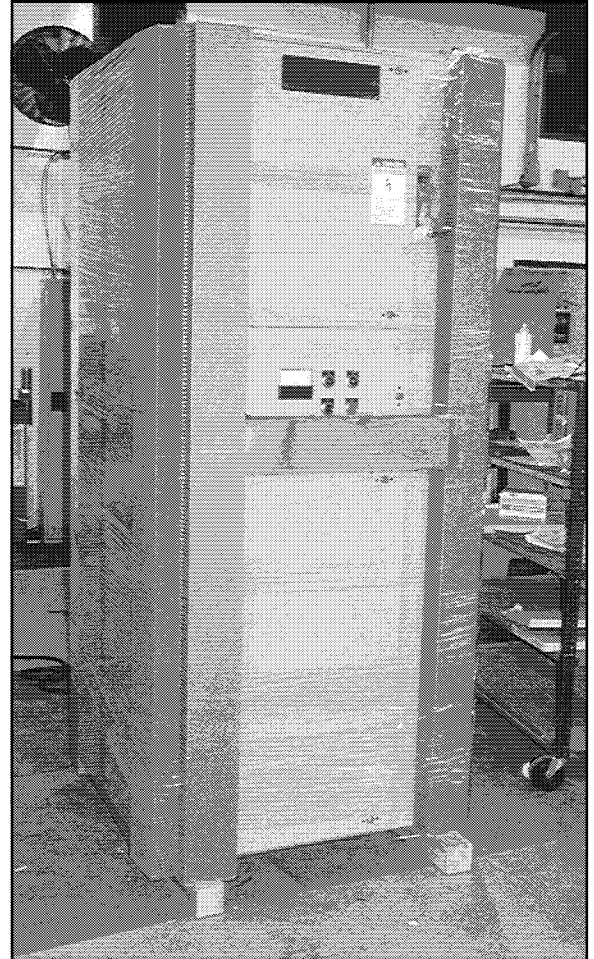
Controllers designed for indoor installation (NEMA Type 1, 12) which are not to be installed and energized immediately, should be stored in a clean, dry space where a uniform temperature prevents condensation. Preferably, the controller should be stored in a heated building, with adequate air circulation and protected from dirt and water. Equipment should be stored where it is not subject to mechanical damage, especially during building construction.

An indoor controller that is to be stored outdoors should be securely covered for protection from weather conditions and dirt. Temporary electrical heating should be installed to prevent condensation. Approximately 150 watts per enclosure is usually adequate.

**NOTE:** All loose packing or flammable materials should be removed before energizing space heaters.

**OUTDOOR EQUIPMENT**

An unenergized controller designed for outdoor installation (NEMA Type 3R, EPIC building, etc.) should be kept dry internally by installing electrical heating or by energizing self-heaters, if provided. All openings, either used or unused should be covered or sealed to prevent the entry of rain, vermin, insects, etc.



**Fig. 5 Storage**



## ROUTINE INSPECTION

Routine scheduled inspection should be established if storage for an extended period is anticipated. This is to check for condensation, corrosion, vermin, and adequacy of space heating.

Prior to inspection, the equipment should be carefully examined for evidence of physical damage, corrosion, or other deterioration.



### **WARNING**

**Do not install equipment found to have damage or deterioration that could affect the unit performance.**



Toshiba fixed type JK medium voltage controllers are AC general-purpose NEMA Class E controllers designed for applications at utilization voltages ranging from 2.3 through 6.6 kV. They are normally used to control motor loads, although other types of loads such as transformers and capacitors are possible.

### CONSTRUCTION

The standard enclosure size is 30" wide by 36" deep by 90" high. In a typical two-high arrangement, each enclosure is divided vertically into three major compartments, each with a separate door. The uppermost and lowermost compartments contain medium voltage controller components (>600V) while the middle compartment contains low voltage components (<600V) (Fig. 6). Other variations of this basic arrangement are possible.

Main horizontal bus is provided when required to supply power to a line-up of controllers. The main bus is located at the rear of the enclosure midway between the top and bottom. A common ground bus is also provided for multiple sections.

Each controller compartment (Fig. 7) consists of:

- 1) Fixed mounted non-load break isolation switch.
- 2) Fixed mounted vacuum contactor.
- 3) Fixed mounted current-limiting power fuses.
- 4) Current transformers for metering.
- 5) Control power transformer and optional potential transformer.
- 6) Load cable terminations.

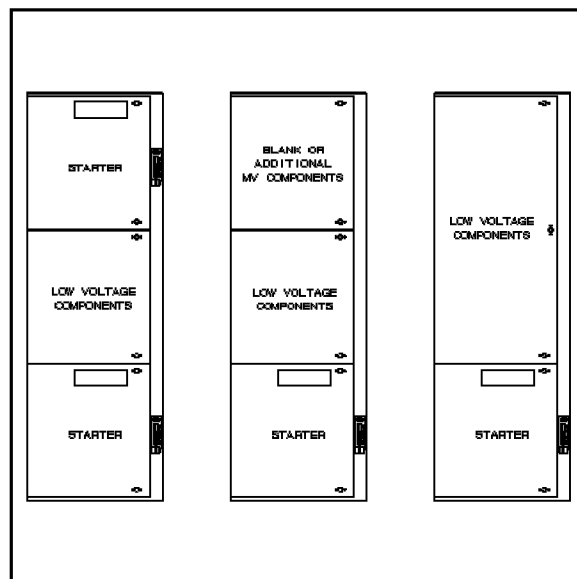


Fig. 6 Typical Controller Arrangements

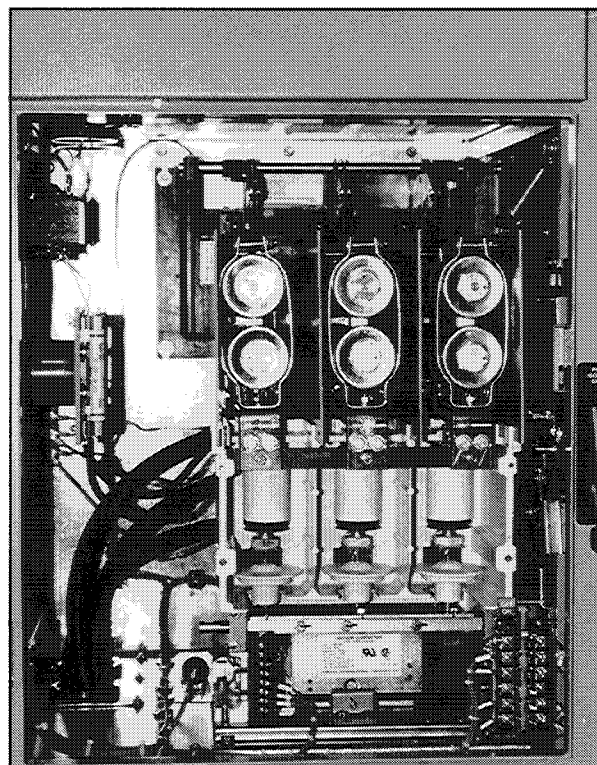


Fig. 7 Controller Compartment



## CONTROLLER COMPARTMENT

### A. Isolation Switch (Fig. 8)

Power is switched on and off to the controller by a fixed-mounted, externally-operated, three-pole isolation switch. When the switch is in the off position, incoming power is isolated from the controller compartment interior by an automatic shutter. For additional safety, the load terminals of the switch are automatically grounded when the switch is off.

Three bolted-in current-limiting power fuses provide primary short-circuit protection for the controller and load circuit. These fuses are connected between the isolation switch and the vacuum contactor. When the switch is closed by operating the external handle, incoming power is applied to the line side of the power fuses. In this position, the motor or other load may be switched on and off by operating the vacuum contactor.

The isolation switch is mechanically interlocked with the vacuum contactor and the compartment door. Details of the interlocking are discussed in section F.

The position of the isolation switch blades can be observed through a window in the medium voltage compartment door. Thus, it is possible to have visual evidence that the power source is isolated before entering the medium voltage compartment. The switch is also provided with lock-out provisions (Fig. 9).

The isolation switch has a maximum interrupting capacity of 0.4 amperes.



**WARNING**

Do not connect additional load to the isolation switch.

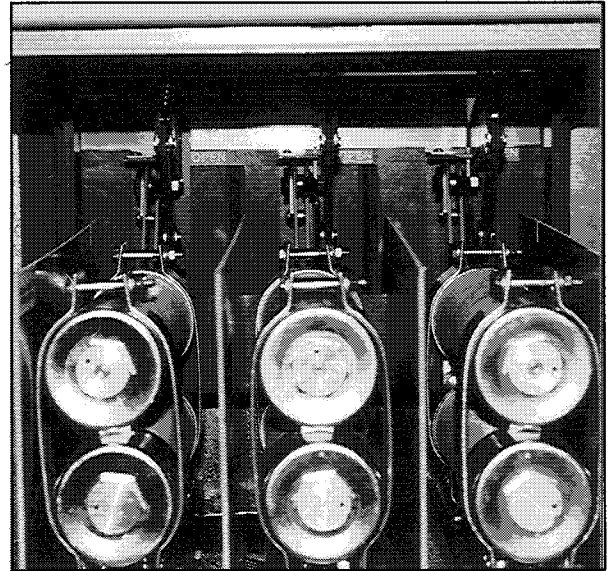


Fig. 8 Isolation Switch



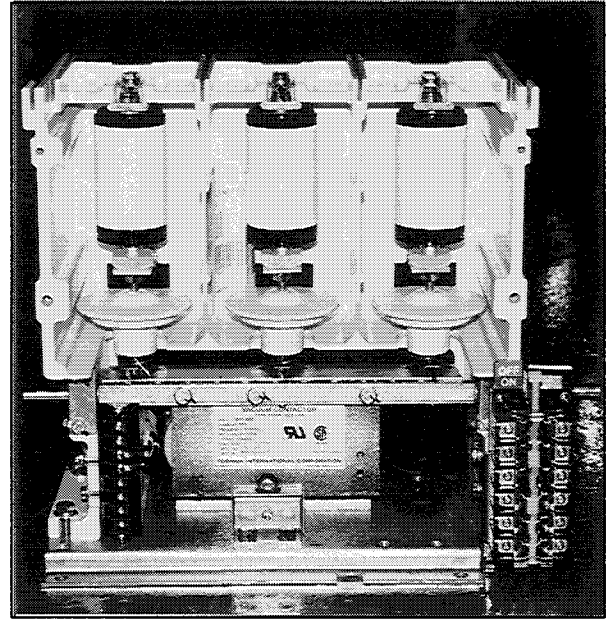
Fig. 9 Isolation Switch Lockout



**B. Vacuum Contactor (Fig. 10)**

The Type HCV-5HA vacuum contactor used in these controllers is a compact, fixed mounted device. It is mounted to the floor of the controller compartment, beneath the isolation switch.

Switching occurs entirely within vacuum bottles which results in long life with virtually no maintenance. The contactor is mechanically interlocked with the isolation switch so that the switch may not be opened or closed unless the contacts of the vacuum contactor are open.



**Fig. 10 Type HCV-5HA Vacuum Contactor**



### C. Outgoing Load Connections

Connections for outgoing load cable are located at the rear of the vacuum contactor. Cables may enter the controller from either the top or bottom of the enclosure through the wireways provided.

The standard termination assemblies are shown in Fig. 11 and Fig. 12. To access cable termination areas, remove fuse barriers and fuses (see Power Fuse Cartridges). Non-shielded cable up to one 350MCM per phase or shielded cable up to one 2/0 per phase can be accommodated through the window (donut) type current transformer and terminated at the provided aluminum mechanical lugs behind the vacuum contactor.

If necessary, the current transformer can be easily removed, to feed load cables through opening windows, by unscrewing the secondary terminal wires and two mounting nuts.

If a ground sensor (optional) is supplied with the equipment, route all of the load cables through the sensor. Ground wires from shielded cable terminators must be routed back through the window type current transformer and ground sensor window before attaching to ground bus.

After installation, be sure the secondary terminal wires on the current transformer are re-connected correctly and securely, the load cables are not pressing on the current transformer excessively, the lugs are torqued at 120 in-lbs for lugs rated for wire ranges from 1/0 to #14 and at 275 in-lbs for lugs rated for wire ranges from 350MCM to #6 and check to see that at least three inches clearance is maintained between live parts of opposite polarity and between live parts and ground.

For aluminum cable, "DE-OX" inhibitor is recommended at the termination.

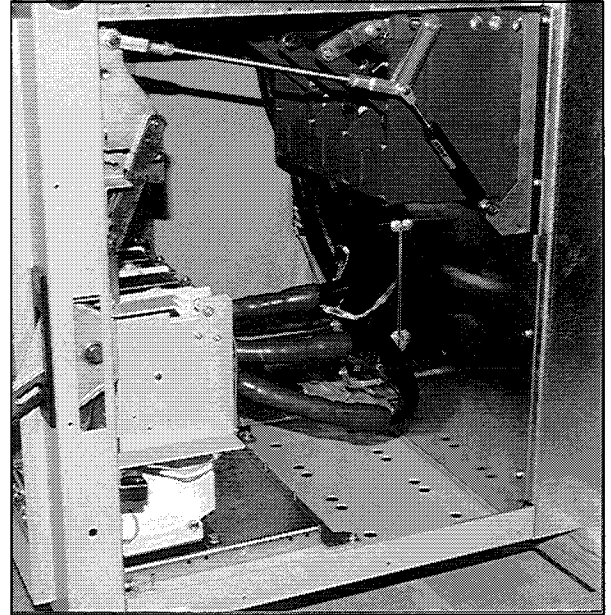


Fig. 11 Load Cable Connection, Top Exit

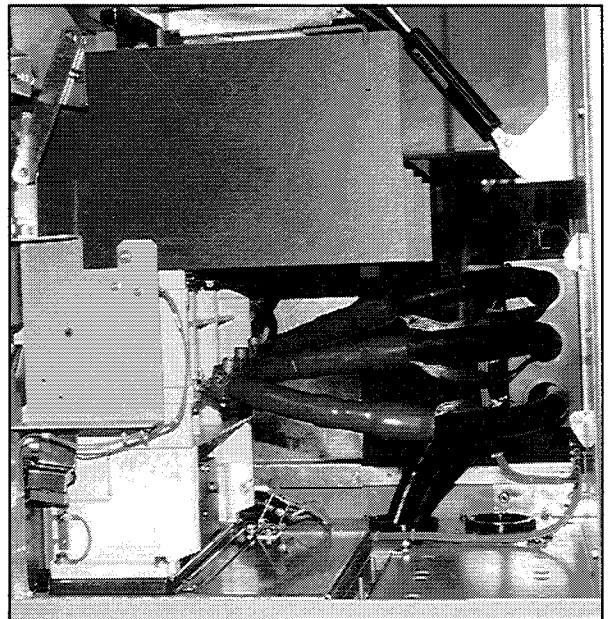


Fig. 12 Load Cable Connection, Bottom Exit



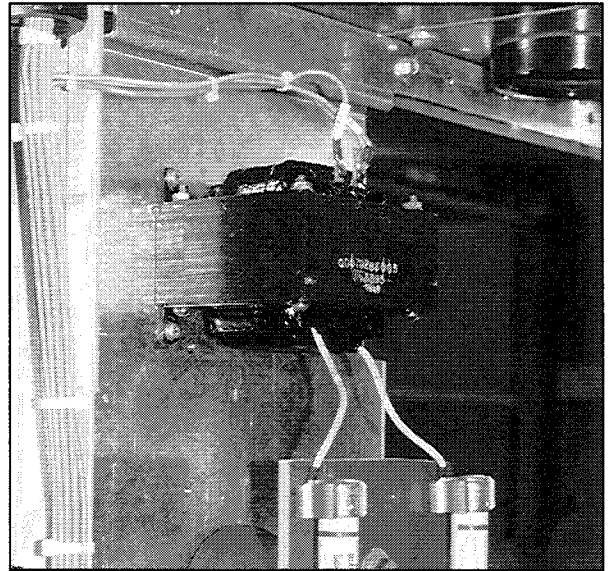
#### **D. Control Power Transformer**

A control power transformer (Fig. 13) is fixed-mounted on left wall of the controller compartment. Power is supplied through the fuses on the primary of the control power transformer from the load side of the main power fuses.

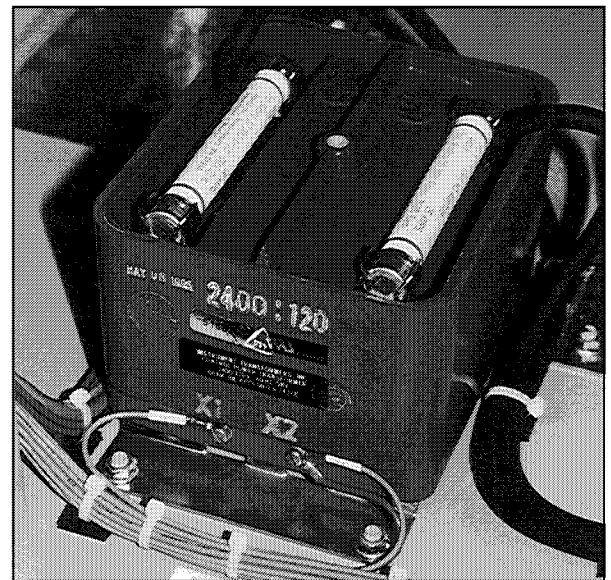
Optional transformer (Fig. 14), may be used as an instrument transformer, can also be mounted in the same compartment.

The transformer is used to supply power to the low voltage circuits of the controller. This includes power for the vacuum contactor operating coil and for various instrumentation.

An electrical interlock is provided to ensure that all load is disconnected from the control power transformer secondary winding before the power isolation switch can be opened or closed.



**Fig. 13 Control Power Transformer**



**Fig. 14 Optional Transformer**



## E. Operating Handle

The external operating handle shown in Fig.15 is used to control the operation of the isolation switch. Moving the handle upward turns the switch on, thus applying incoming power to the main current-limiting fuses.

Moving the handle down opens the isolation switch, de-energizing all medium voltage incoming power to the controller compartment. At the same time an automatic shutter within the switch closes providing an effective barrier between the controller compartment and the incoming supply. The opening of the switch also causes the line side of the power fuses to be grounded.

## F. Interlocks - Mechanical

### a. Door Interlock

A mechanical interlock is provided to prevent opening or closing the medium voltage compartment door unless the switch operating handle is off (Fig. 16).



Fig. 15 Operating Handle

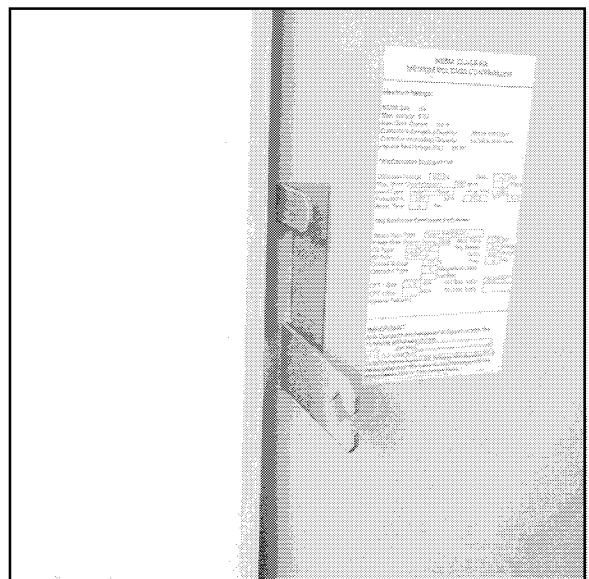


Fig. 16 Door Interlock



**b. Handle Interlock**

Two mechanical interlocks are provided to prevent operating the switch handle improperly.

The first interlock prevents moving the handle from OFF to ON unless the compartment door is closed (Fig. 17).

The second interlock prevents the switch handle from being moved in either direction unless the contacts of the vacuum contactor are open (Fig. 18).

**c. Vacuum Contactor Interlock**

The vacuum contactor is mechanically interlocked to prevent it from closing unless the switch handle is in the fully ON or fully OFF position. The interlock shown in Fig. 18 provides this function.

If the switch handle is in an intermediate position, and a closing signal is given to the contactor, it is mechanically prevented from operating.

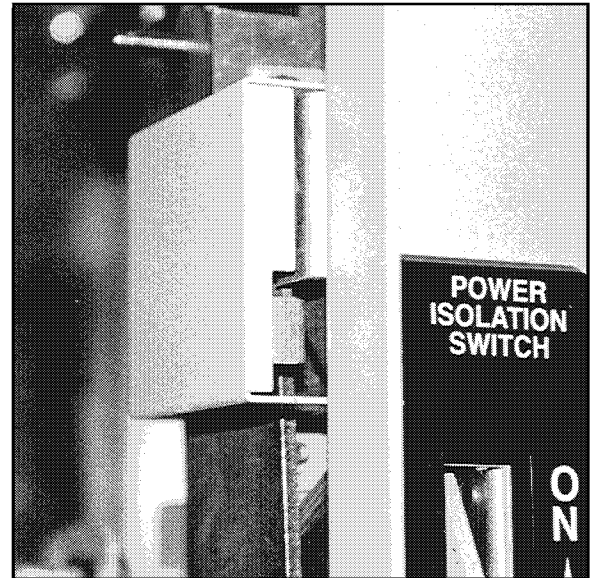


Fig. 17 Handle Interlock to Door

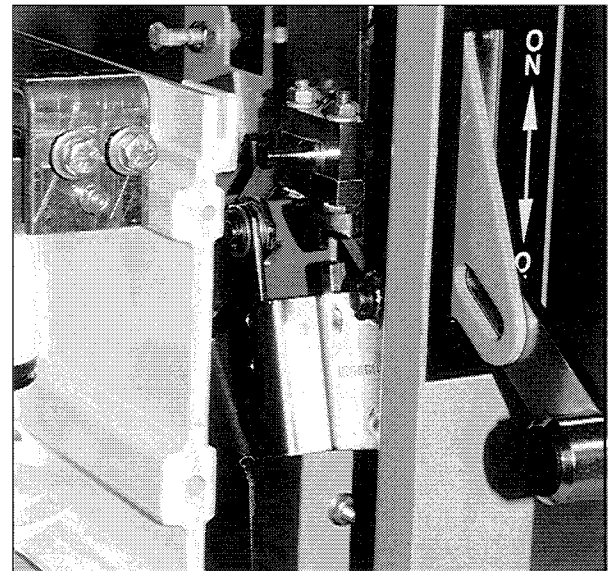


Fig. 18 Handle Interlock to Vacuum Contactor



### G. Interlocks - Electrical

#### a. Control Power Interlock (CPI)

The control power interlock (CPI) is a microswitch which is directly driven by the operation of the switch handle (Fig. 19). This normally open switch is closed only when the handle is fully ON. It ensures that all load is disconnected from the control power transformer secondary winding before the isolation switch can be operated.

As the switch handle is moved from ON to OFF, the CPI opens before the main contacts of the power isolation switch. Conversely, during closing of the switch, the CPI contacts do not close until the switch contacts have fully closed. The isolation switch is therefore only subjected to making and breaking currents equal to the no-load magnetizing current of the transformer.

**⚠ WARNING** Do not connect any additional load to the isolation switch.

#### b. Test Power Interlock (TPI)

The test power interlock (TPI) is a scheme provided to allow simulated operation of the controller from a separate control power (test) source with power removed from the medium voltage circuit. During normal controller operation with the isolation switch closed, control power is fed from the control transformer secondary to a receptacle located on the lower left hand side of the vacuum contactor (Fig. 20). A plug, inserted into this receptacle, supplies power to the controller's low voltage compartment.

For testing purposes, the isolation switch must be turned off and the controller door must be opened. The plug is then removed and inserted into an ordinary extension cord.

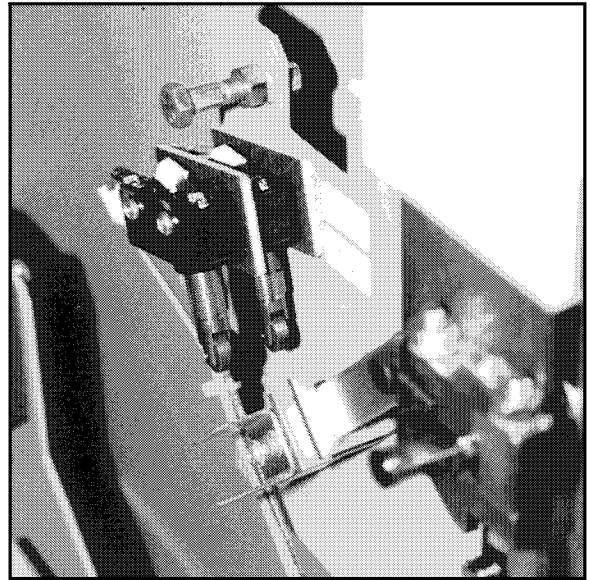


Fig. 19 Control Power Interlock

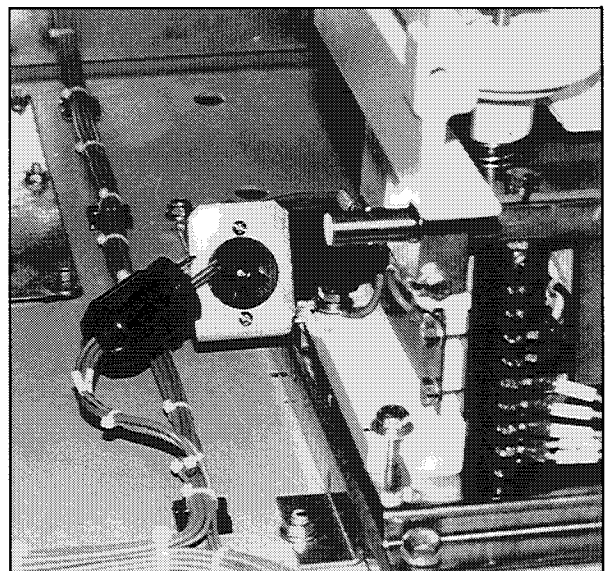


Fig. 20 Test Power Receptacle



Plugging the extension cord into a conventional outlet provides 120VAC power for performing control circuit operational tests while the medium voltage circuit is de-energized.

### **LOW VOLTAGE COMPARTMENT**

The low voltage compartment contains controller components rated 600 volts maximum. These may include such items as overload relays, pilot devices, control relays, etc.



**Hazardous Voltage. Turn off and lock out control circuit power before servicing.**

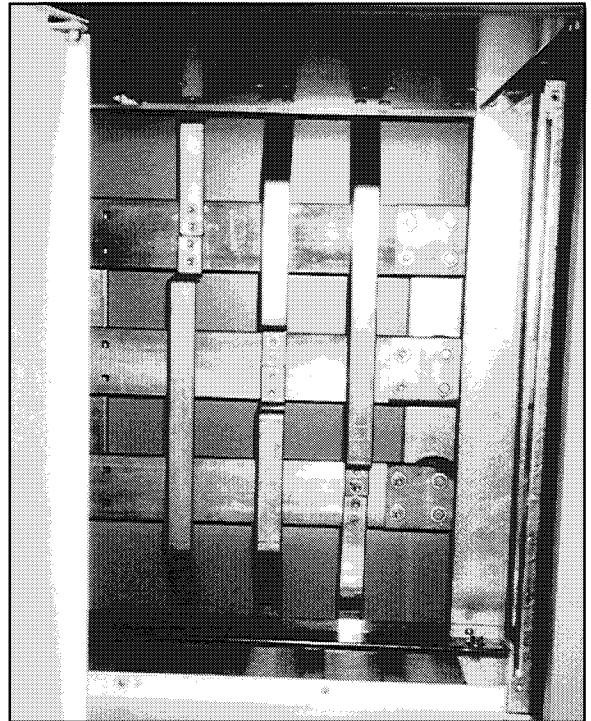
The location and size of the low voltage compartment will vary depending on the particular controller arrangement. In a typical two-high controller, the low voltage compartment is located in the center of the enclosure.

A subpanel is located behind the low voltage door which is used to mount various relays and other devices. The subpanel is hinged in such a way it can be swung open if necessary to gain access to main horizontal bus which is located directly behind (Fig. 21).

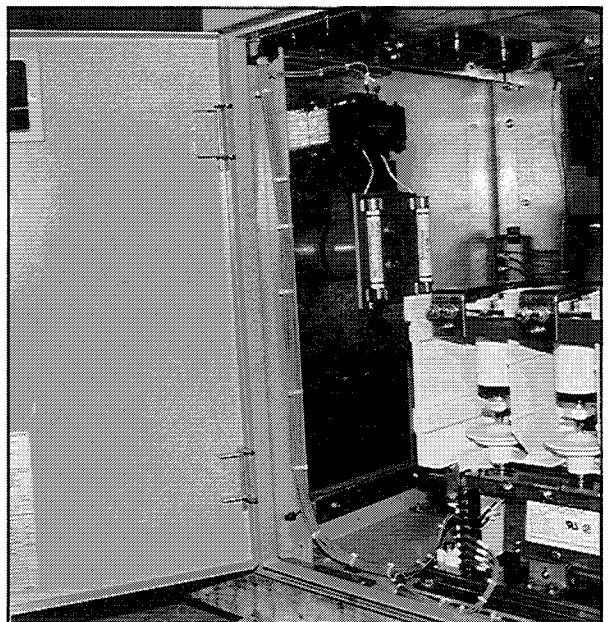


**Hazardous Voltage. Turn off and lock out all control and primary power before opening this panel.**

Low voltage vertical wiring (Fig. 22) routes into the upper and lower left hand corners of the low voltage compartment. A horizontal low voltage wireway is provided at the lower front of each low voltage compartment. At each end of the horizontal wireway there is an opening for inter-cubicle control wiring.



**Fig. 21 Low Voltage Subpanel Opened to Expose Main Bus**



**Fig. 22 Typical Low Voltage Vertical Wiring Route**



## MAIN BUS COMPARTMENT

Main bus bars extending horizontally throughout a line-up are located in an isolated compartment located in the rear center of the enclosure (Fig. 23). From the main bus, riser bars supply power to each individual controller. Standard main bus bars are copper with tin plating. A copper ground bus is also located in the main bus compartment and is used to provide a common ground point between cubicles. Vertical ground riser bars extend from the common ground bus into each medium voltage controller compartment.

Access to the main bus compartment can be obtained either by removing the enclosure back sheet or by swinging open the hinged low voltage subpanel.

### **⚠ DANGER**

**Hazardous Voltage. Turn off and lock out all control and primary power before accessing this compartment.**

Bus splice links (Fig. 24) are furnished for joining the main bus and ground bus between shipping sections. With the low voltage subpanel swung open, all splice links can be installed from the front of the unit. Refer to Installation Section for details.

## PREPARED SPACES

Prepared spaces are compartments equipped for future addition of controllers and are supplied with the following components:

- Isolation Switch
- Riser bus

To convert a prepared space to a functional controller, the following must be added:

- Vacuum Contactor and interlock
- Handle mechanism for Isolation Switch
- Power fuse cartridges and barriers
- Current and control power transformers

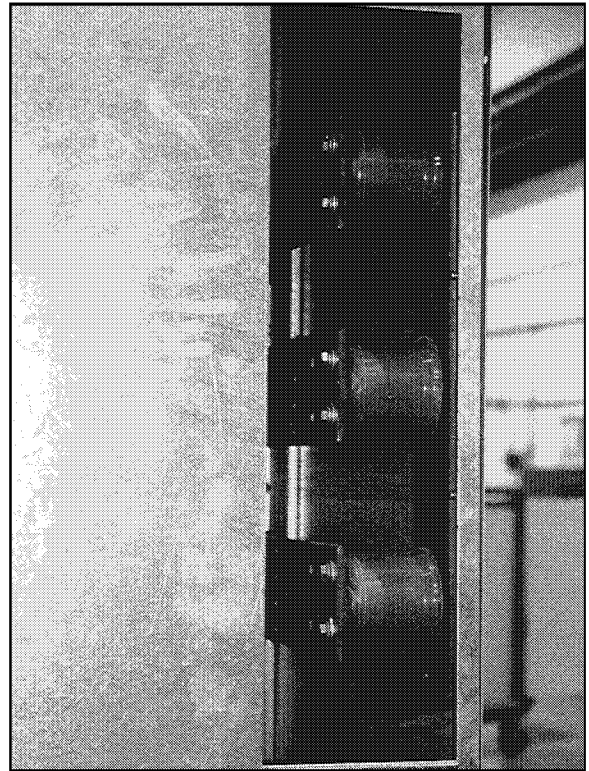


Fig. 23 Main Bus Compartment

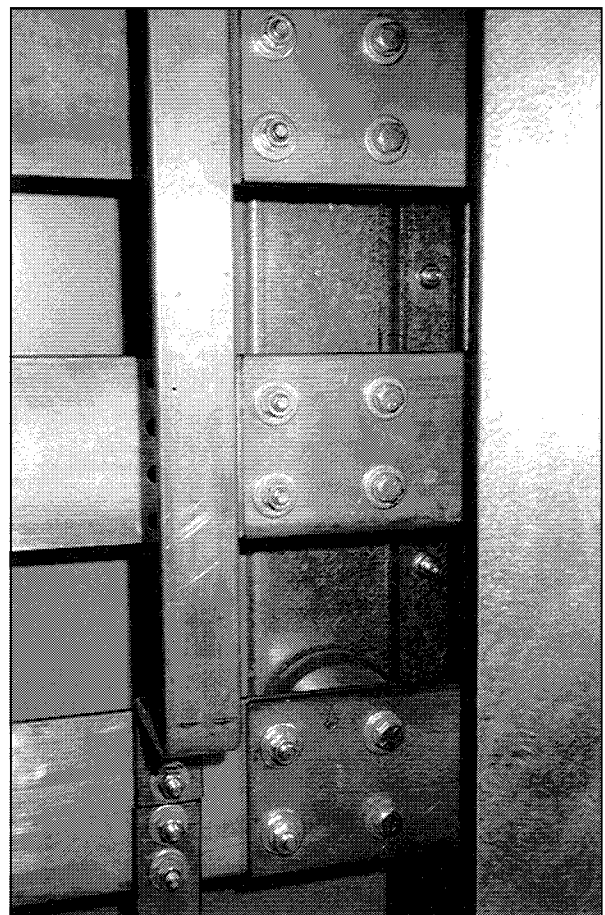


Fig. 24 Bus Splice Links



**CONTACTOR RATINGS****TABLE 1. CONTACTOR TYPE HCV-5HA (Magnetically Held)**

Maximum Voltage	7200 Volts
Maximum Current	400 Amps
Interrupting Capacity	7000 Amps RMS Sym. @ 5 kV Max 4500 Amps RMS Sym. @ 7.2 kV Max
Permissible Switching Frequency	1200/Hour
Mechanical Life	2,500,000 Operations
Electrical Life	250,000 Operations
Closing Time	80 ms or less
Opening Time	25 ms or less
Arcing Time	10 ms or less
Pick-Up Voltage AC or DC	85% Rated(Hot) - 75% Rated(Cold)
Drop-Out Voltage AC or DC	50% Rated(Hot) - 40% Rated(Cold)
Rated Control Voltage AC *	115/120 or 230/240 V 50/60 Hz
Rated Control Voltage DC *	120/125 or 240/250 V
Coil Circuit Inrush	670 VA AC (700W DC)
Coil Circuit Holding	85 VA AC (85W DC)
Auxiliary Contact Arrangement	3 N.O. - 3 N.C. (Max-STD)
Auxiliary Contact Rating	10 A, 600 V (NEMA Class A600)

\* Coil drive board setting required (120 VAC standard).

**CONTACTOR TYPE HCV-5HAL (Latched Type)**

Permissible Switching Frequency	300/Hour
Mechanical Life	250,000 Operations
Tripping Voltage	65-75% Rated DC
Tripping Current	4.8 Amp DC Max

Other characteristics of latched contactor same as magnetically held type except number of auxiliary contacts is reduced to 2 N.O.-3 N.C. Standard operating voltage is 120VAC Close/125VDC Trip.



**CONTROLLER RATINGS****TABLE 2. SHORT-CIRCUIT & WITHSTAND CAPABILITY**

Interrupting Capacity (Sym. Amperes)	Interrupting Capacity (Sym. MVA)	Short Time Capability 30 Seconds	Short Time Capability 1 Second	Dielectric Withstand 1 Minute	Impulse Voltage Withstand
50,000 RMS @2.3-6.6kV	200@2.3 kV 350@4.0 kV 400@4.6 kV 570@6.6 kV	2400A	6000 A	AC 19 kV DC 26 kV	BIL 60 kV

**TABLE 3. CONTINUOUS CURRENT**

Enclosure Type	Max. Continuous Amperes  One-High controller	Max. Continuous Amperes  Lower Controller in a Two-High Stacking Arrangement	Max. Continuous Amperes  Upper Controller in a Two-High Stacking Arrangement
NEMA-1 Ventilated	360	360	320
NEMA-1 Non-Ventilated	320	320	280
NEMA-12, 3R	310	310	280



TABLE 4. APPROXIMATE\* MAXIMUM HORSEPOWER BASED ON CONTINUOUS CURRENT

Enclosed Maximum Continuous Current (amperes)	Maximum Horsepower at Utilization Voltages								
	2300 Volts, 3-Phase			4000 Volts, 3-Phase			6600 Volts, 3-Phase		
	Syn. Motors		Ind. Motors	Syn. Motors		Ind. Motors	Syn. Motors		Ind. Motors
	0.8 PF	1.0 PF		0.8 PF	1.0 PF		0.8 PF	1.0 PF	
360	1500	1750	1500	2500	3000	2500	4000	5000	4000
320	1250	1500	1250	2250	2500	2250	3500	4500	3500
310	1250	1500	1250	2000	2500	2000	3500	4000	3500
280	1000	1250	1000	1750	2250	1750	3000	3500	3000

\* Motor FLA depends on mfg, speed, & other factors which must be considered.



## RATING VERIFICATION - PRIOR TO INSTALLATION

The maximum fault capability of the power system at the point of installation should be verified and must not exceed the short-circuit rating of the controller (See RATINGS section). All system accessories such as surge suppressers, lightning arresters, etc. should be checked to verify their ratings capacity.

### **⚠ DANGER**

**Do not exceed the ratings specified on the controller nameplate or system accessories.**

## LOCATION

Overhead should be checked for plumbing condensation, sprinklers or similar possible sources of trouble. A clearance of 1/2 inch should be provided between a wall and the rear of the controller for indoor equipment, when rear access is not required. If rear access is required in either environment, a minimum of 30 inches should be provided.

A minimum of 48 inches working space should be allowed in front of the controller. This minimum should be increased if necessary to accommodate movement around open enclosure doors to comply with applicable codes.

## SERVICE CONDITIONS

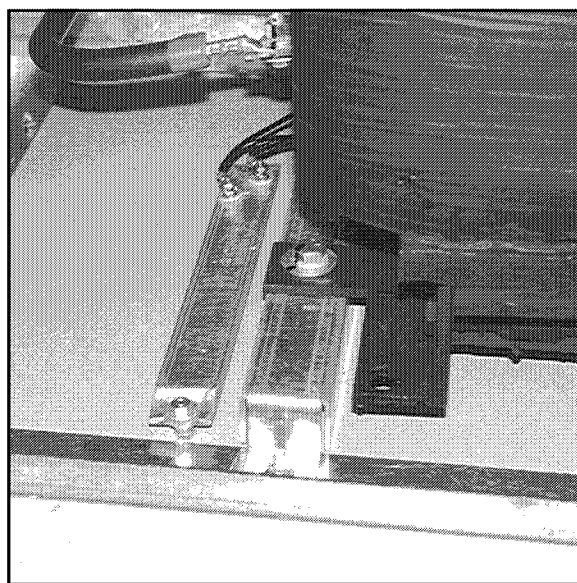
Toshiba medium voltage controllers are intended for usual service conditions as defined by NEMA. The equipment should not be exposed to corrosive or explosive fumes, dusts, vapors, dripping or standing water, abnormal vibration, shock, tilting, or other abnormal operation conditions. The temperature of the ambient air surrounding the controller should be between the limits of 0°C(32°F) and +40°C(104°F). The altitude of the equipment installed should not exceed 3300 ft (1000m).

**NOTE:** Temperature or altitude conditions outside of the usual limits may require derating or other special equipment, such as heating, cooling or ventilation. Contact Toshiba for further information.

If the location for installation is damp, space heaters may be required. If space heaters (Fig. 25) are furnished inside the controller, they should be connected in accordance with the wiring diagram furnished.

### **⚠ WARNING**

**Do not install this equipment in areas where unusual service conditions exist, unless the equipment has been specially designed for the particular environment.**



**Fig. 25 Typical Space Heater**



## INSTALLATION SITE PREPARATION

It is recommended that site preparation be completed before the controller is unpacked, so that possible problems such as headroom, conduit location, cable tray locations, ventilation, etc. can be solved, assuring a proper installation in compliance with the building plans and codes.

The floor on which the controller will be placed must be level so that the enclosure is not distorted when bolted in place. Ensure the equipment adequately clears any underground raceways or cables.

## MOUNTING

Each shipping section must be leveled and firmly secured to its supporting foundation. Steel shims may be used for final leveling (Fig.26), if necessary. When three or more shipping sections are to be arranged in one continuous line-up, the center shipping section should normally be the first located.

Follow the equipment outline drawings to determine the location of the mounting bolt holes and any conduit locations.

Sill channels may or may not be furnished, depending on order specifications. Refer to outline drawings furnished for location of sill channels, if furnished.

Various methods may be used to anchor the enclosure to the foundation, including expandable inserts or "J" bolts embedded in concrete. The recommended size for anchor bolts is 1/2" (Fig. 27).



**WARNING**

**Heavy Equipment.**  
Enclosure must be securely anchored to prevent tipping over.

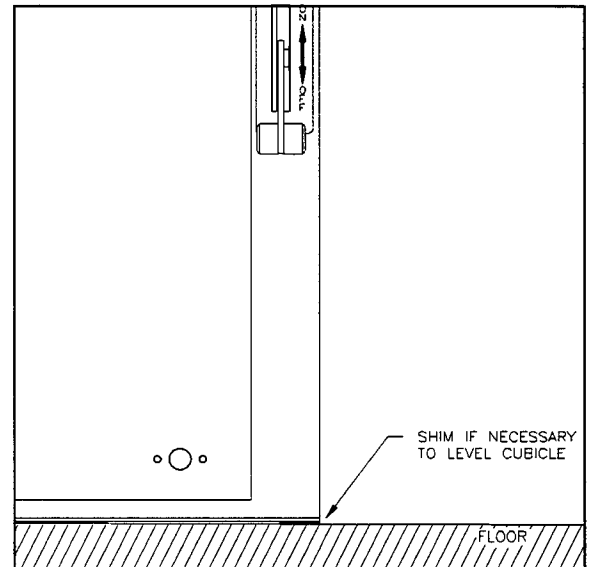


Fig. 26 Leveling Using Shims

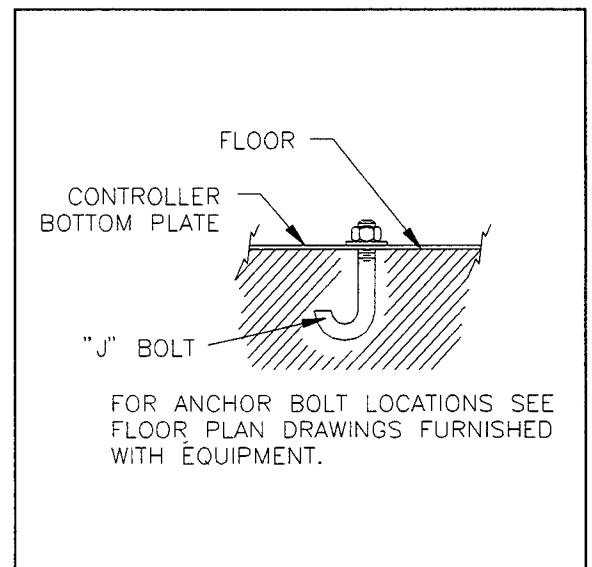


Fig. 27 Securely Anchor the Controller



## GROUNDING

The controller line-up must be grounded in accordance with the requirements of the National Electrical Code. Proper equipment grounding must be established before making any incoming power connection. If a main ground bus (Fig. 28) is furnished, make the ground connection to this bus. If there is no ground bus, the sections which are shipped separately should be connected in such a way as to ensure a continuous grounding path.

Each section contains a vertical ground bus (Fig. 29) extending from the main ground bus or ground pad to each controller compartment.

Special attention should be paid to protection for operating personnel, to protection of equipment itself, (i.e. such as ground fault relays, if used) and protection of sensitive transducers or control devices that are electronic in nature.

The following may be used as a general guide with regard to equipment grounding.

Controller used as service equipment for a grounded system or as a main section for a separately derived system:

- a. The grounding electrode conductor (ground wire) sized in accordance with NEC 250-94 should be run from the grounding electrode to the controller ground bus or ground terminal. See also NEC 250-91 (a) and 250-92 (a).
- b. Unless already done at the factory, a main bonding jumper should be installed from the incoming grounded connector bus (neutral) to the ground bus or designated grounding point. If a jumper is not furnished, one having a size in accordance with NEC 250-79 (c) should be selected.
- c. Steps (a) and (b) should effectively connect together the grounding electrode, the controller frame, all outgoing equipment grounding conductors and the grounded neutral bus of the system.

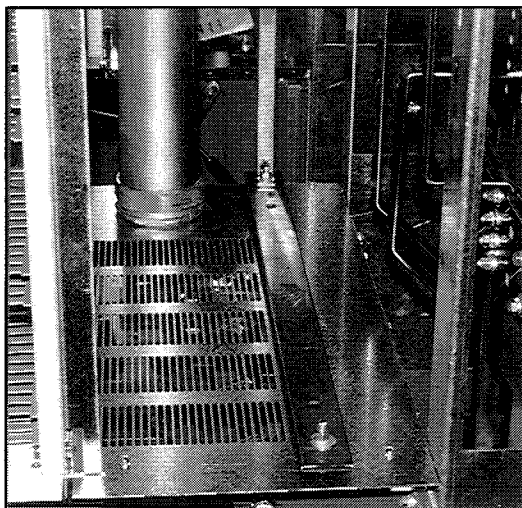


Fig. 28 Main Ground Bus

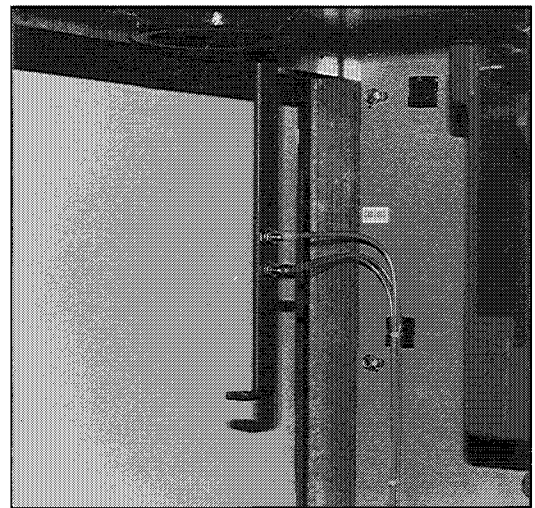


Fig. 29 Vertical Ground Bus



- d. No connection should be made to ground on the load side of any neutral disconnecting line or any sensor used for ground fault protection. No connections should be made between outgoing grounding connectors and the neutral.
- e. Where the controller or system is dual-fed (double-ended) and has ground fault protection, special precautions are necessary to accomplish proper grounding and bonding.

Controller used as service equipment for an ungrounded system or as a main section for a separately derived system.

- a. A grounding electrode conductor (ground wire) sized in accordance with NEC 250-94 should be run from the grounding electrode to the controller ground bus or ground terminal. See also NEC 250-91(a) and 250-92(a).
- b. If the system is grounded at any point ahead of the controller, the grounded conductor should be run to the controller in accordance with NEC 250-23 (b) and connected to the ground bus or ground terminal.
- c. Steps (a) and (b) should effectively connect together the grounding electrode, the controller frame, all outgoing equipment grounding connectors and any grounded conductor which runs to the controller.

Controller not used as service equipment or as a main section for a separately derived system, and used on either a grounded or ungrounded system:

- a. The controller frame and any ground bus should be grounded by means of equipment grounding conductors having a size in accordance with NEC 250-95 and run with the main supply conductors or by bonding to the raceway enclosing the

main supply conductors in accordance with NEC 250-91 (b).

- b. Ground leads should be connected to cable potheads/shields as specified by the manufacturer of these devices.



## CONNECTIONS

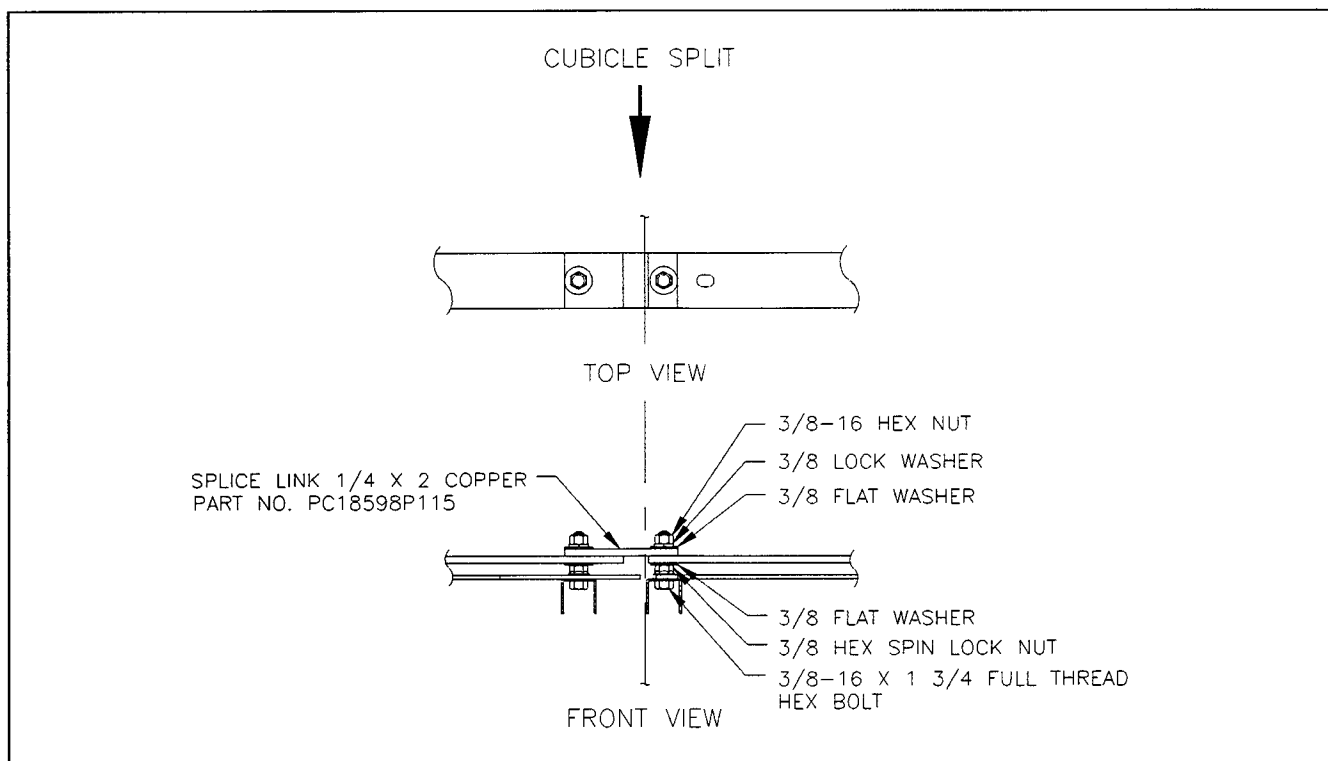
Cable and wire bundles that enter the controller enclosure should be routed to avoid interference with moving parts. Minimum bending radius for the type of cable used should be observed.

Power cables should be braced and/or laced to withstand short circuit forces wherever such cables are unsupported. Power cables should be adequately sized to carry the motor full load current in accordance with NEC requirements, and have an adequate voltage rating. Cables should be dressed and terminated as appropriate to the voltage class and cable manufacturer's recommendations.

Main power bus and horizontal ground bus are supplied with links to join shipping sections together. These should be installed in accordance with Fig. 30 through Fig. 32.

All access covers, barriers, partitions, etc. that are temporarily removed during installation must be replaced.

**NOTE:** Covers and braces supplied only for protection during shipment should not be replaced. All debris and tools should be removed from each compartment as cabling is completed.



**Fig. 30 Ground Bus Splice Connections**



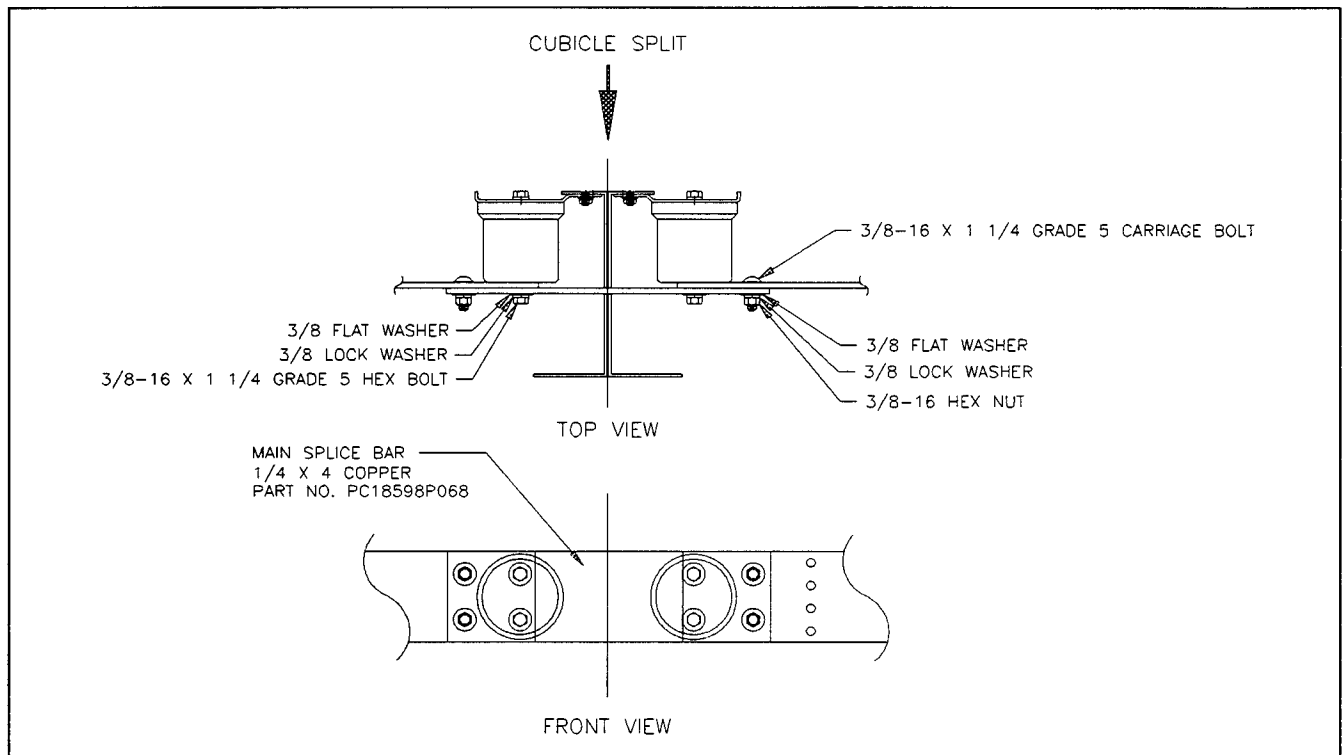


Fig. 31 Main Bus Splice Connections - 1200A Main Bus

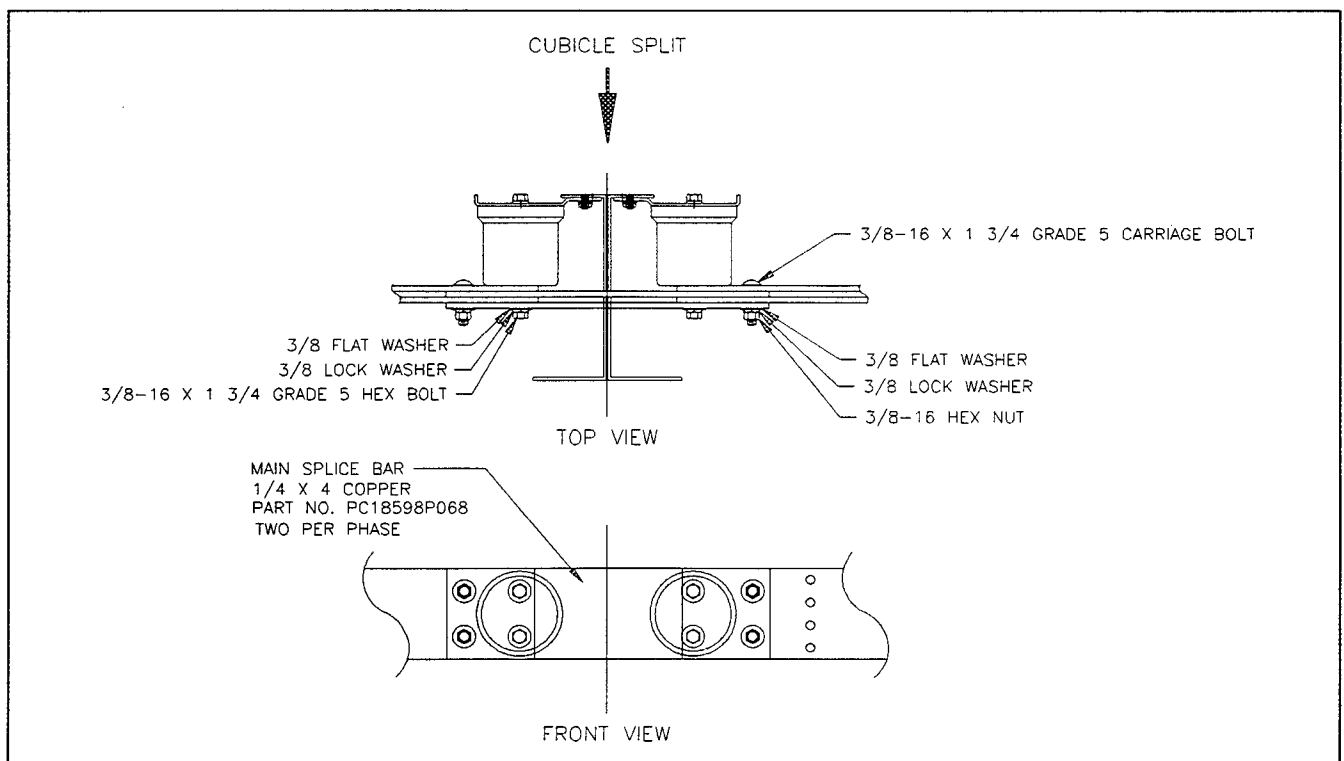


Fig. 32 Main Bus Splice Connections - 2000A Main Bus



## INCOMING LINE

Incoming power cable connections should be made at the points shown on the wiring diagram furnished with the equipment. These connections will normally be made in a separate incoming compartment to bus lugs or to an incoming load interrupter switch or vacuum circuit breaker.

## OUTGOING LOAD

Outgoing load connections are made in the controller compartment at the points shown in Fig. 11 and Fig. 12.

The load cables should be routed through the wireways furnished within the enclosure. Typical routing of load cables for a two-high controller arrangement is depicted in Fig. 33 and Fig. 34 for both top and bottom entry of cables.

Load cable termination arrangements for certain controllers such as reduced voltage autotransformer types may differ from those shown in this manual. In these cases refer to the drawings furnished with the equipment.

To access cable termination areas, remove fuse barriers as shown in Fig. 54, then remove fuses (see Power Fuse Cartridges in the next section).

After completing the cable termination and re-installation of the fuses, re-install the four vertical and one angle shaped horizontal fuse barriers and position them per Fig. 54.

### **⚠ WARNING**

Failure to properly install fuse barriers can result in major equipment damage and possible personnel injury.

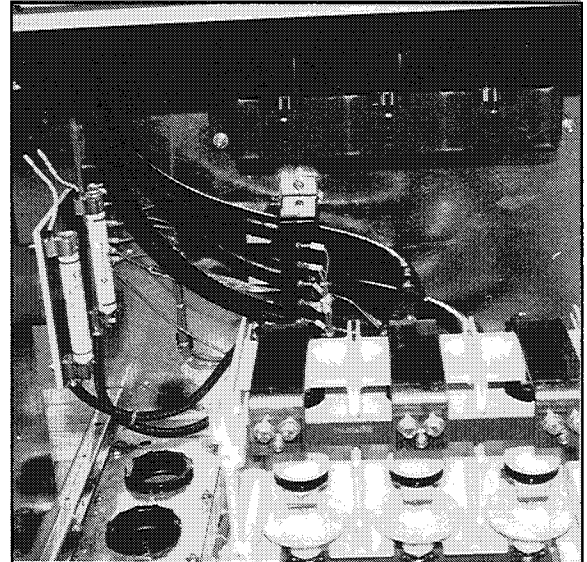


Fig. 33 Controller Load Wiring - Top Entry

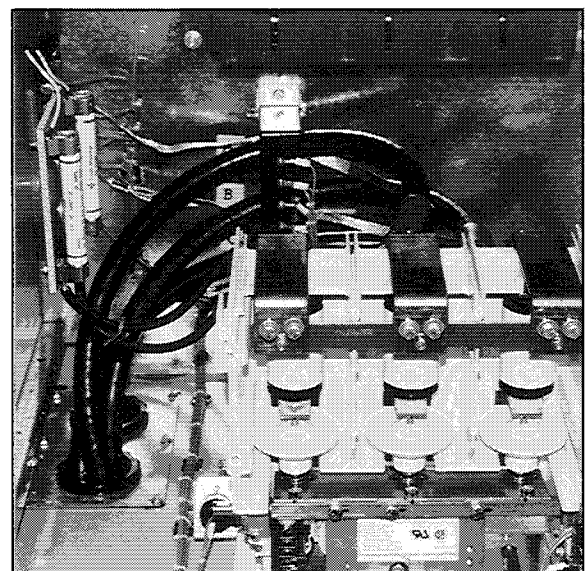


Fig. 34 Controller Load Wiring - Bottom Entry



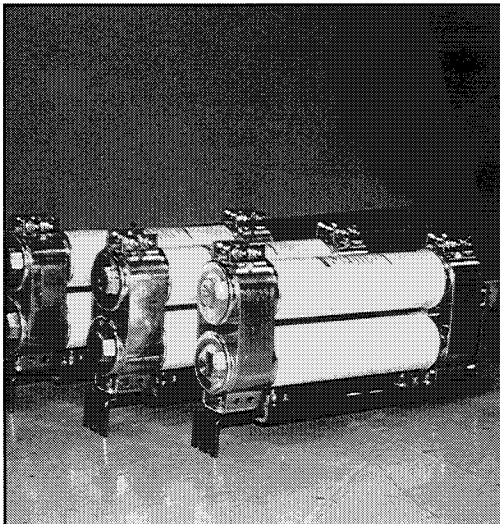
**POWER FUSE CARTRIDGES (Fig. 35)**

□ To remove power fuse cartridge:

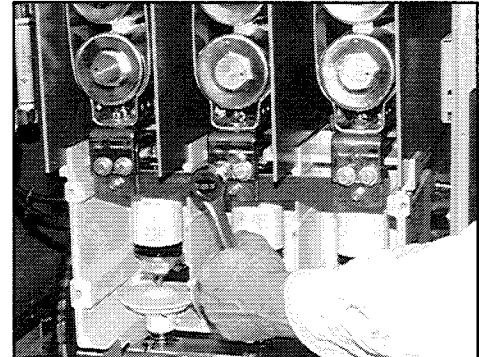
1. Loosen the front two sems bolts (Fig. 36).
2. Lift up the front end ( Fig. 37) then slowly slide out of the compartment.

□ To install power fuse cartridge:

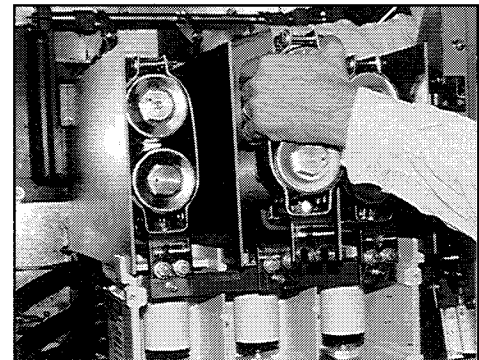
1. Position the cartridge on top of the vacuum contactor (Fig. 38).
2. Slowly slide the cartridge in untill the back bus stab engages inside the isolation switch opening slot (Fig. 39).
3. Lower the front end bus into the two sems bolts (Fig. 36) then tighten and torque the sems bolts to 10-15 ft-lbs.



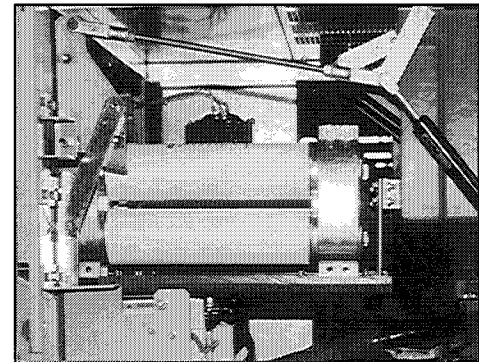
**Fig. 35 Power Fuse Cartridges**



**Fig. 36 Removing Fuse Cartridge**



**Fig. 37 Removing Fuse Cartridge**



**Fig. 38 Installing Fuse Cartridge**



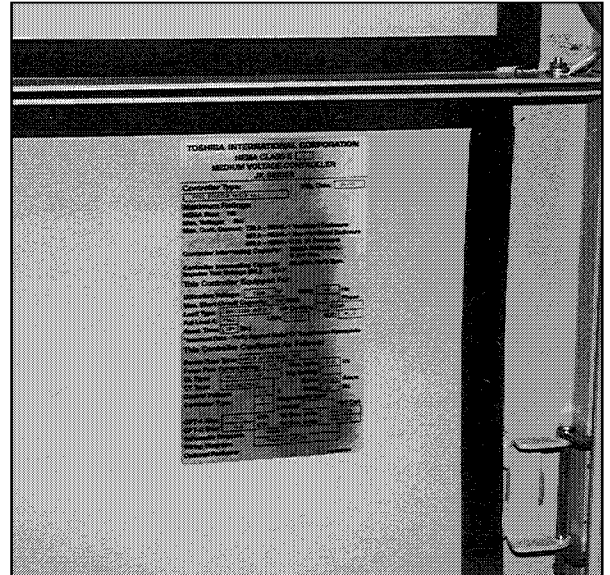
**Fig. 39 Installing Fuse Cartridge**



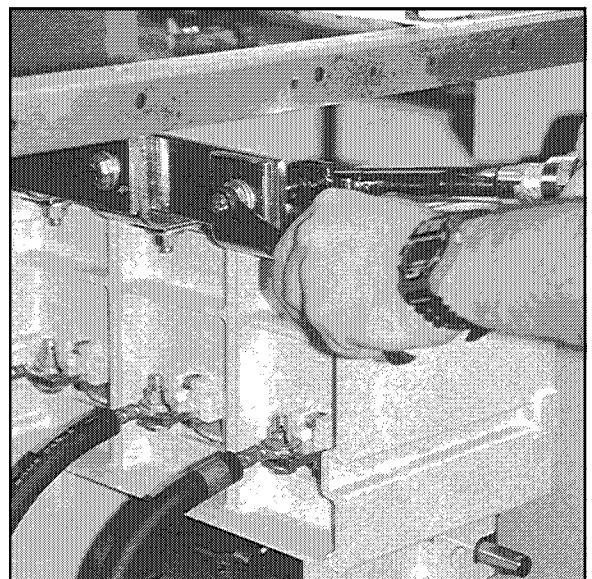
## GENERAL

**AFTER INSTALLATION, BUT BEFORE ENERGIZING THE CONTROLLER** for the first time, follow the procedure below to verify that the equipment is properly installed and functional.

- ☐ There is a rating data label (Fig. 40) on the inside of each medium voltage compartment door. Verify that the controller ratings properly match the system data by checking the following:
  1. Verify agreement of full load current, locked rotor current and acceleration time (for motor loads) with motor nameplate. If the load is other than a motor, check the load data against the data on the rating label.
  2. Verify that system voltage, number of phases and frequency matches controller rating.
  3. Verify that available short circuit current of power system is less than rated short circuit capacity of controller.
- ☐ Check connections - Although the equipment and devices have been completely tested at the factory, a final field check should be made that all electrical wiring and bus bar connections are correct and have not become loose in transportation (Fig. 41). Refer to MAINTENANCE Section for electrical joint specification.
- ☐ All blocks or other temporary braces used for shipment must be removed.



**Fig. 40 Data Label on Controller**



### Fig. 41 Check Connections



- ☐ Before closing the enclosure, all metal chips, scrap wire and other debris left over from installation must be cleaned out.
- ☐ If there is an appreciable accumulation of dust or dirt, the enclosure should be cleaned by using a brush, vacuum cleaner or clean, lint free brush.
- ☐ The integrity of all bus bar supports must be checked for secureness and damage.
- ☐ Care should be exercised that when covers are installed and doors closed, no wires are pinched and that all enclosure parts are properly aligned and tightened.
- ☐ A supply of spare parts, fuses, etc. should be established.
- ☐ Instruction manuals and diagrams should be collected and filed.

#### WIRING CHECK (Fig. 42)

- ☐ Field wiring should be checked for clearance to live busses where necessary, physically secured to withstand the effects of fault current.
- ☐ All grounding connections should be checked.
- ☐ Each motor should be connected to its intended controller, and phase rotation should be correct prior to startup.
- ☐ Shorting jumpers (Fig. 43) for current transformer secondary windings must be removed once the secondary circuit is completed. A circuit transformer must not be operated with its secondary windings open.
- ☐ Changes made to circuit diagrams during installation should be recorded.

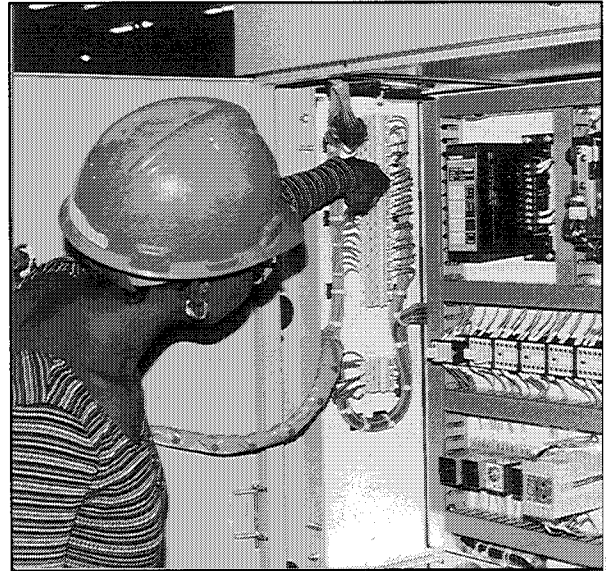


Fig. 42 Wiring Check

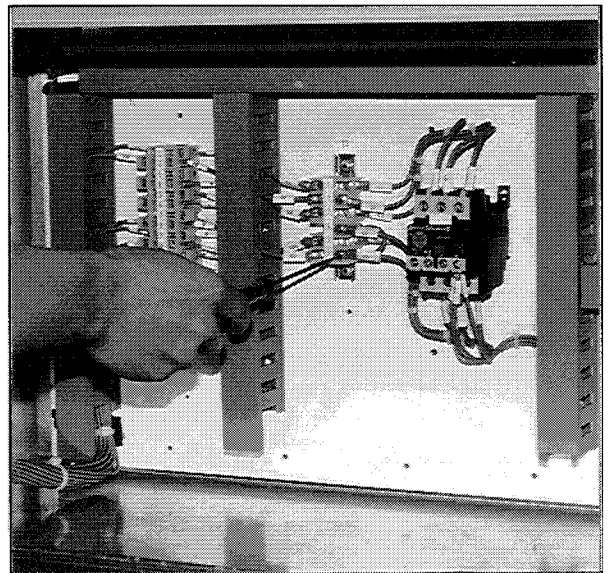


Fig. 43 Removing Current Transformer Shorting Jumpers



## DEVICE/MECHANISM CHECKS

- All devices should be checked for damage (Fig. 44). All necessary repairs or replacements should be made.

**⚠ WARNING** Do not energize damaged equipment that has not been repaired and verified.

- Ensure that safety signs are not covered or obscured by paint.

**⚠ WARNING** Do not remove, cover or destroy any safety signs.

- The setting of any adjustable current and voltage trip mechanisms should be verified to the proper values.

**NOTE:** Damage from faults can be reduced if devices used for short circuit and ground fault protection are chosen and set to operate at values as close to minimum as feasible, while allowing normal transients.

- All switches, relays and other operating mechanisms should be manually exercised to make certain that they are properly aligned and operate freely.
- Operating mechanisms such as interlocks, key switches, etc. should be checked for function as intended for protection of personnel and equipment.
- Overload relays should be checked to be sure they are selected and adjusted to the proper settings per the load nameplate data (Fig. 45).
- Power circuit fuses should be selected and installed in accordance with the application requirements. Fuses must be completely inserted in their holders. See section Power Fuse Cartridges.



Fig. 44 Device/Mechanism Check

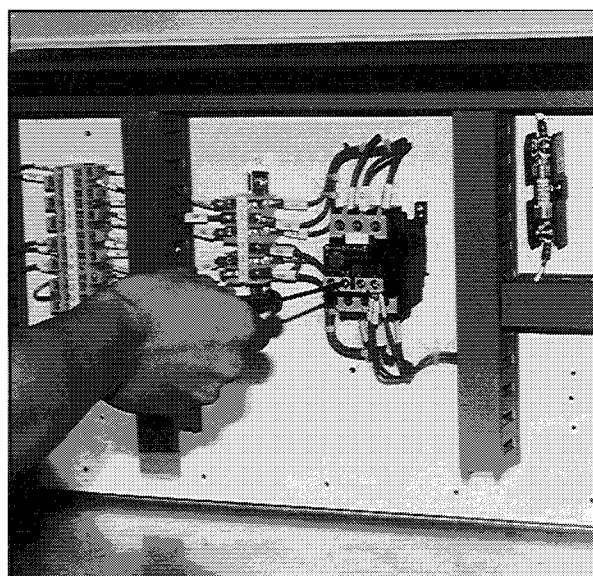


Fig. 45 Overload Setting Check



**ELECTRICAL CHECKS**

- ☐ With incoming power isolated and all loads disconnected electrically, the control circuit and other mechanisms should be exercised to determine that the devices operate properly. An auxiliary source of control power will be necessary to provide power to the electrical operators.

**⚠ WARNING**

**Electrical shock hazard. Do not touch energized components during a test using auxiliary power.**

- ☐ The ground fault protection system (if furnished) should be tested in accordance with the instructions furnished with the device.
- ☐ An electrical insulation test should be performed to ensure that the controller and associated field wiring are free from short circuits and grounds. The preferred method is to perform a dielectric test at 2.25 times the nominal system voltage plus 2000 volts. This should be done phase-to-ground, phase-to-phase and phase-to-neutral (if applicable), with all switches and circuit breakers opened. Disconnect any devices which may have limited dielectric strength and that are not intended for this test.

The light or buzzer, or both, used to indicate breakdown should be calibrated to indicate failure with an output current between 1.5 and 2.0 milliamperes per 1000 volts applied.

**⚠ WARNING**

**Hazardous voltages are present during dielectric testing which can result in serious injury or death.**

**High potential tests should be performed only by qualified personnel.**

**Refer to safety instructions provided with the test equipment.**

- ☐ All devices must be set to their normal or OFF position before energizing incoming power.



## INITIAL ENERGIZATION

Energizing a medium voltage controller or line-up of controllers for the first time is potentially dangerous. Therefore only qualified personnel, as defined in the SAFETY section of this manual, should energize the equipment (Fig. 46). If faults caused by damage or poor installation practices have not been detected in the PRE-ENERGIZATION CHECK section, major damage including personal injury can result when the power is applied. Extra precaution is recommended on initial energization of the equipment.

**⚠ DANGER**

**Hazardous Voltage.**  
Improperly installed, or damaged equipment will result in severe injury, death, and property loss. Correct all problems prior to energizing this equipment.

**⚠ WARNING**

Only qualified personnel should energize this equipment.

In order to minimize the risk of injury or damage, there should be no load on the controller or group of controllers when incoming power is first turned on. All downstream loads, including those such as distribution equipment and other remote devices, should be turned off. The isolation switch ahead of each controller should be in the off position.

The equipment should be energized in sequence by starting at the source end of the system and working towards the load end. First the main devices, then the feeder devices and then the branch circuit devices should be closed.

With all removable barriers in place and all doors closed and latched, the devices should be turned on with a firm, positive motion. Protective devices and switches that are not quick-acting should not be "teased" into the

closed (or open) positions. The isolation switch handle should be moved between OFF and ON positions in a single continuous smooth movement. (Fig. 47)

After all disconnect devices have been closed, contactors may be operated to turn on loads such as motors, transformers, heaters, etc.



Fig. 46 Preparing For Initial Energization



Fig. 47 Closing Isolation Switch



In order to ensure continued reliable and safe operation of the equipment, a program of periodic maintenance must be established. Operating and environmental conditions will dictate the frequency of inspection required. NFPA Publication 70B "Electrical Equipment Maintenance" (Fig. 48) may be used as a guide for setting up the maintenance program.

### MAINTENANCE RECORD

A permanent record of all maintenance work should be kept (Fig. 49). At a minimum, this record should include information on:

- 1) Items inspected
- 2) Test reports
- 3) Equipment condition
- 4) Corrective actions or adjustments
- 5) Date of work
- 6) Comments

The degree of detail will depend on the operating conditions.

#### **⚠ WARNING**

**Contact with energized components can cause severe injury or death. Turn-off and lock out Primary and Control Circuit Power before servicing.**

#### **⚠ WARNING**

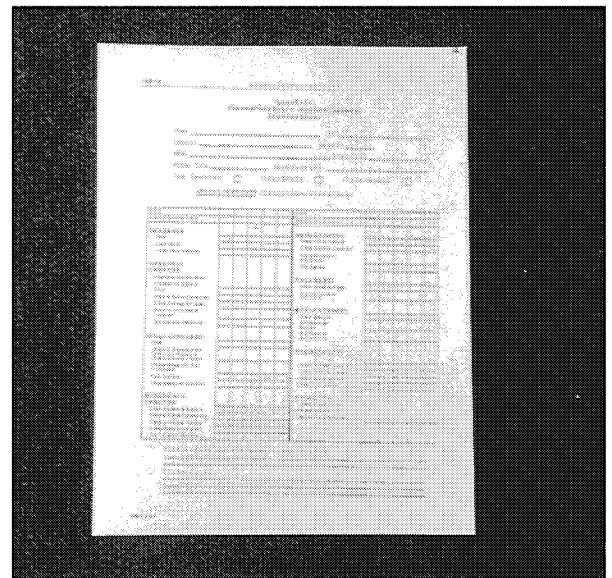
**Improper maintenance can cause severe injury, death, and extensive property damage. Only qualified and authorized persons are to install, operate, or service the equipment.**

#### **⚠ WARNING**

**This equipment utilizes both low and high voltage for operation. Verify that all test equipment is suitable for the voltage being checked.**



**Fig. 48 NFPA 70B, Electrical Equipment Maintenance**



**Fig. 49 Maintenance Record**



NOTE: Refer to the SAFETY section of this manual for important information.

After disconnecting and locking out incoming power and before performing any maintenance, it is recommended that a safety ground be connected to the main power bus (Fig. 50). After maintenance is complete, perform the checks in the PRE-ENERGIZATION CHECK section of this manual before restoring power.

The following pages detail maintenance procedures recommended for fixed type JK medium voltage controllers. In general, the following items should be included on the maintenance checklist:

- Cleaning
- Checking and tightening of electrical connections
- Checking of fuses and fuse connections
- Proper installation of any removable barriers
- Vacuum contactor maintenance

The information presented here is intended to cover preventive maintenance only. It does not cover major rework or repair. The following MAINTENANCE SHOULD BE PERFORMED AT LEAST ANNUALLY or more frequently depending on operating conditions.

## GENERAL INSPECTION

- ☐ Thoroughly clean the equipment, removing all dust, dirt and other accumulations. Wipe insulators clean using a clean, dry cloth. Do not use petroleum-based solvents or cleaners.
- ☐ Check for any signs of moisture inside the enclosure. If there are signs of dripping water entering the enclosure, eliminate the source. Thoroughly dry any insulation which shows signs of wetness and repeat the dielectric test procedure given in the PRE-ENERGIZATION CHECK. Replace insulators, if necessary.

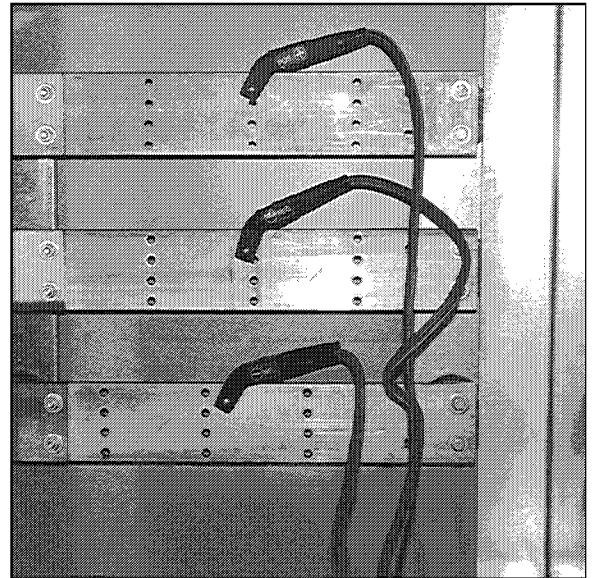


Fig. 50 Attaching Safety Ground



- ☐ Check for any signs of rusted or corroded parts.
- ☐ Check for free movement of all moving parts and mechanisms. Lubricate if necessary with Toshiba B8 grease.

**⚠ WARNING**

**Grease is conductive. Do not apply grease to electrical insulation.**

**ELECTRICAL JOINTS**

- ☐ Examine all visible terminals and joints for signs of overheating (Fig. 51). An overheated connection will appear discolored. Be suspicious of any conducting joint which has a darker color than other similar joints.
- ☐ Check all bolted connections for tightness. The proper torque is dependent on the size of the hardware and the materials used. As a general guide, use the following table:

Hardware Size	Torque(ft-lbs)
1/4-20	4-6
5/16-18	10-15
3/8-16	20-30
1/2-13	40-50

The above values apply to metal-to-metal joints, e.g., copper-to-copper, etc. When torquing a bolt threaded into an insert molded into a plastic part, use approximately 2/3 the torque shown.

**POWER FUSES**

- ☐ Check the condition of the back stab terminals on the cartridge for any signs of damage or discoloration (Fig. 52). If there is any excessive build-up of dirt or other foreign material, wipe clean and relubricate with a light coat of Toshiba B8 grease, making sure that no grease gets

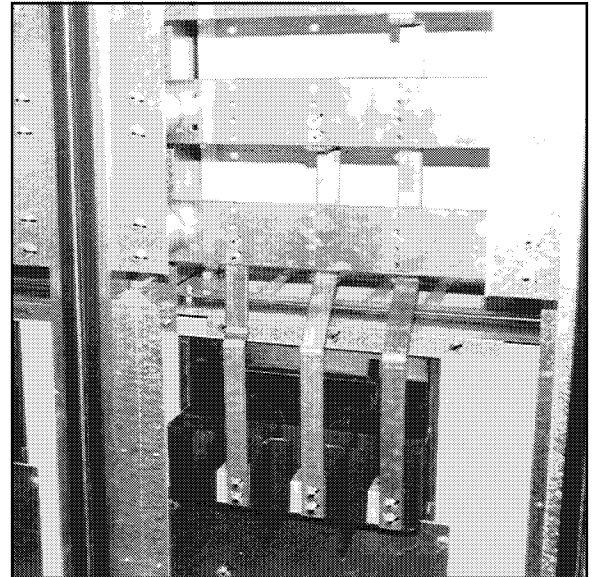


Fig. 51 Check Electrical Joints

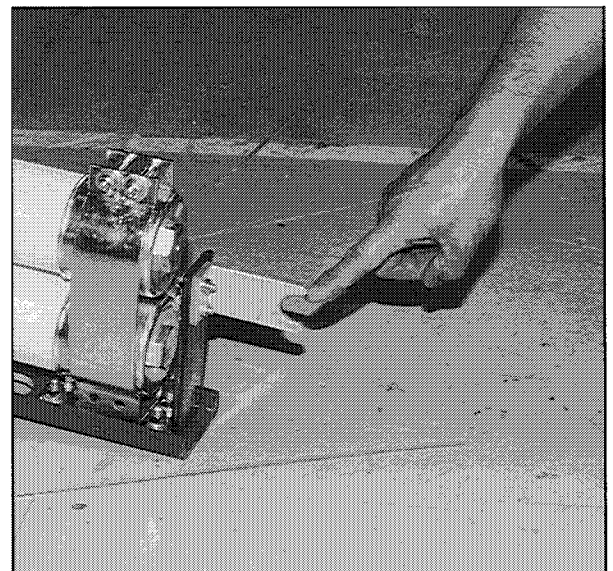


Fig. 52 Checking Stab on Power Fuse Cartridge



on the insulated fuse housing.

- Wipe off any dust or dirt which may have accumulated on the inside or outside of the power fuse cartridge or on the vacuum contactor housing.
- Check the power fuses for any signs of discoloration. A fuse barrel which appears darker than others indicates overheating. Possible causes of fuse overheating, other than load problems, are misapplication (fuse current rating too small), loose fuse clips, or damaged fuse.
- Check the torque on the bolts which clamp the fuse clips to the fuse ferrules (Fig. 53). The proper torque is 4-6 lb-ft.
- Check the fuse barriers for cleanliness and proper positioning as shown in Fig. 54. There are four vertical barriers located between and outside fuses. A fifth angle shaped barrier, is positioned horizontally across the four barriers toward the back.

## VACUUM CONTACTOR

- Maintenance instructions for the HCV-5HA vacuum contactor are provided in a separate publication, number VF00W103.

**▲ CAUTION** Radiation Exposure Hazard. X-Radiation may cause illness or injury. Stay at least 1 meter (3.3 feet) away from the contactor during high-potential tests.

## ISOLATION SWITCH

The isolation switch (Fig. 55) provided in each controller is a bolted pressure type device. It is designed to maintain proper adjustment and contact pressure over its mechanical life of 10,000 close-open cycles. Under normal operating conditions, no maintenance is required other than periodic inspection and cleaning.

- Wipe off any dust or dirt which may have accumulated on the switch housing, the insulating blade drive links and the shutter.

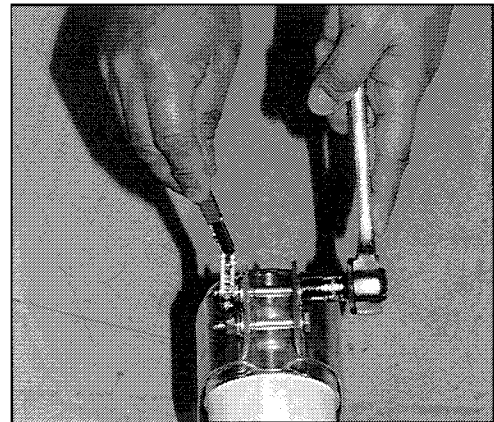


Fig. 53 Fuse Clips

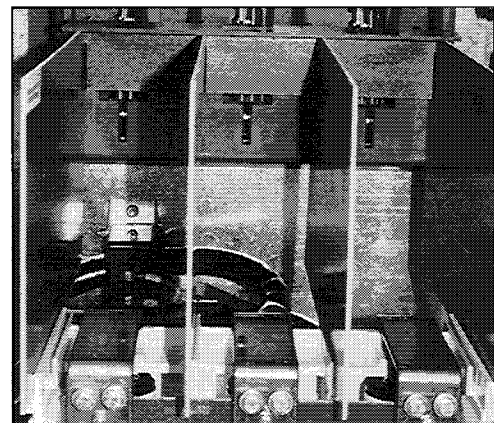


Fig. 54 Fuse Barrier Placement

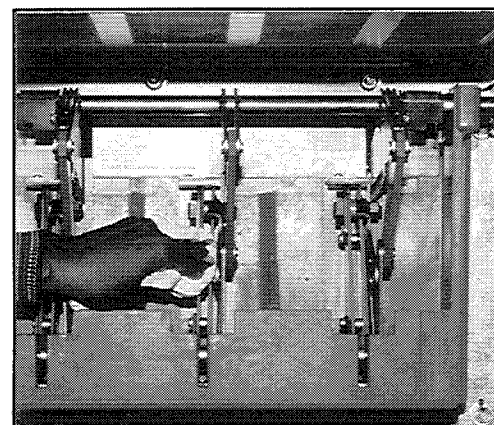


Fig. 55 Checking Isolation Switch



- Open and close the switch and verify that no excessive force is required. Observe that the line terminal shutter opens and closes properly. Lubricate the moving parts of the handle mechanism and, if necessary, apply a light coat of Toshiba B8 grease to the inside contact surfaces of the switch blades.

**⚠ WARNING**

**Grease is conductive. Do not allow grease to contact the switch housing or the insulated shutter.**

- Examine the current-carrying switch blades for any sign of discoloration due to overheating.

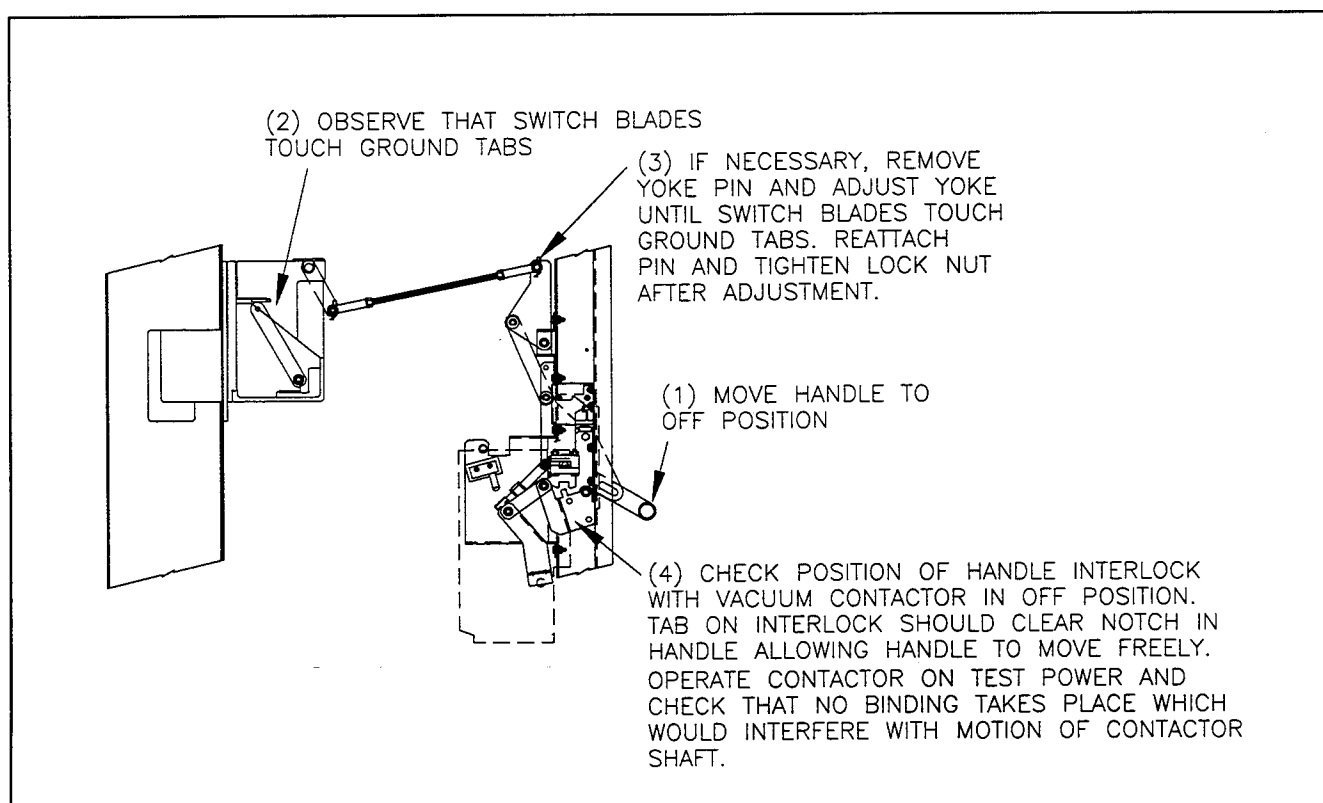
Each bolted pressure switch blade assembly is pre-torqued and adjusted to the proper settings at the factory. **Do not** attempt to change the torque settings or replace individual parts of this assembly in the field.

Should it ever become necessary to replace the blade assemblies, contact the nearest Toshiba representative.

### SWITCH HANDLE MECHANISM AND INTERLOCK

The handle mechanism which operates the isolation switch is adjusted at the factory and under normal operation requires no further adjustment. Adjustment can be checked, however, as follows (Fig. 56):

- 1) Move handle to full OFF position.
- 2) Observe that isolation switch blades are in contact with the ground pads.
- 3) If adjustment is required, loosen lock nut securing yoke on handle end of connecting rod. Remove pin which attaches yoke to handle drive lever. Turn yoke in required direction to achieve adjustment defined in step 2.



**Fig. 56 Switch Mechanism And Interlock Adjustment**



Re-attach yoke and pin to drive lever and tighten yoke lock nut.

- 4) Check the position of the handle interlock with the vacuum contactor in the OFF position. The tab extending from the interlock should clear the notch in the handle allowing the handle to be moved freely between OFF and ON. Operate the contactor on test power and check that there is no binding and that the contactor is able to reach its full travel in both directions.

The moving joints of all linkages should be occasionally lubricated with a light coat of Toshiba B8 grease.

- Check that the CPI electrical interlock (microswitch) operates each time the handle is moved. The CPI (control power interlock) should close approximately 10° before the handle reaches the full ON position. As the handle is moved from ON to OFF, the CPI switch should open by the time the handle has moved approximately 10° or one inch (Fig. 57).
- Check that the handle interlock to the vacuum contactor operates freely. Lubricate with Toshiba B8 grease if necessary. Refer to the GENERAL DESCRIPTION section for the location of the handle mechanical interlocks and the CPI electrical interlock.

## INTERLOCKS

- Circumvent the handle interlock by pushing a screwdriver through the slot and operate the handle several times.

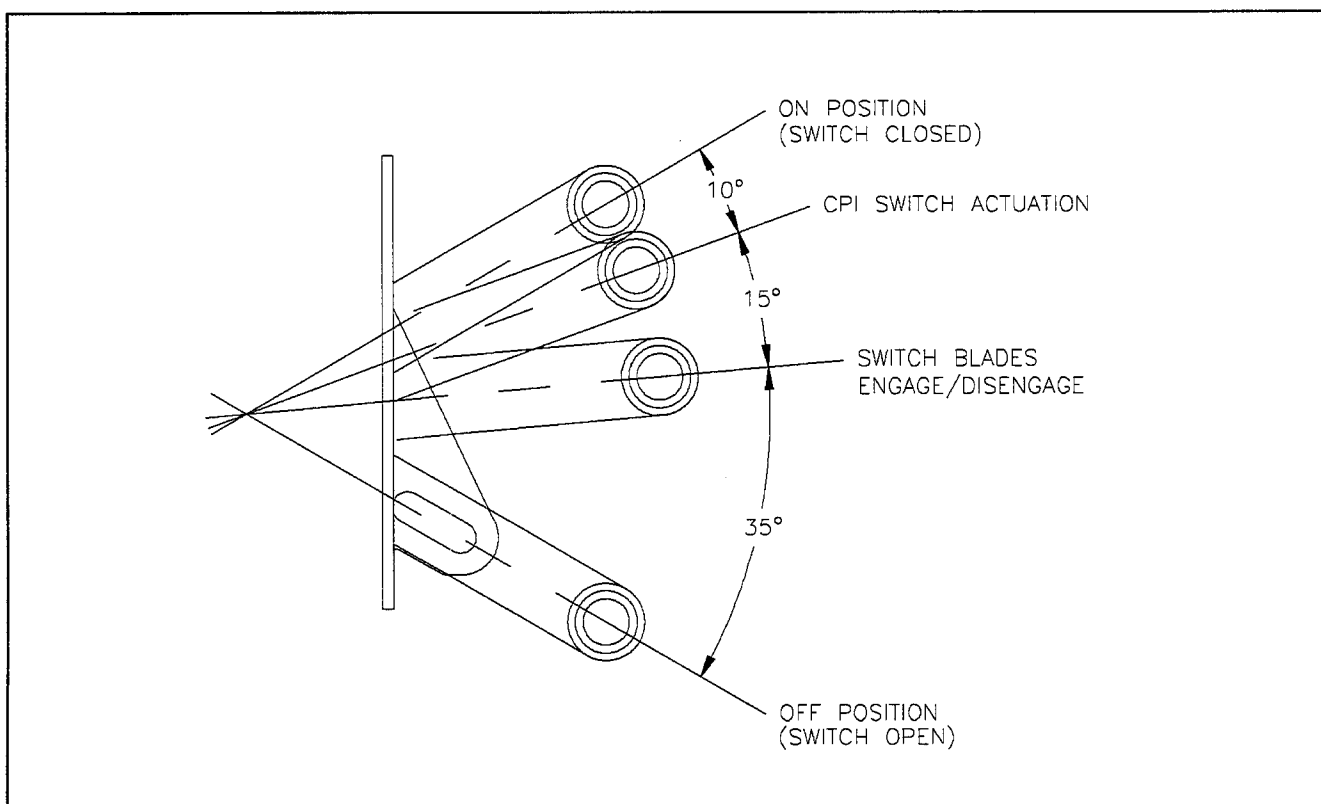
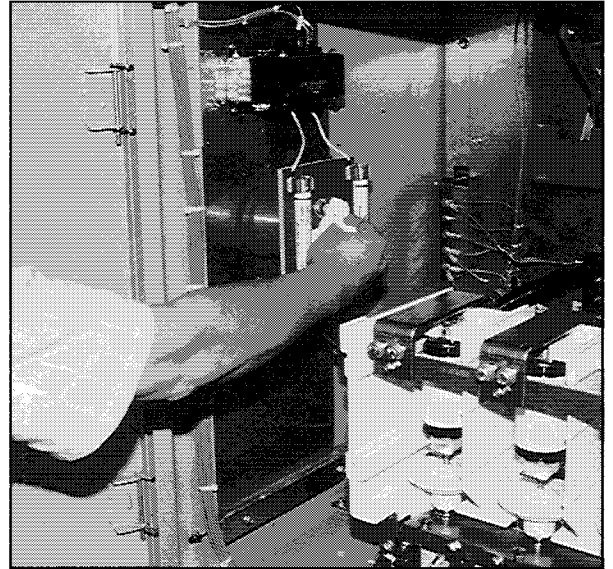


Fig. 57 Interlock Sequence Check

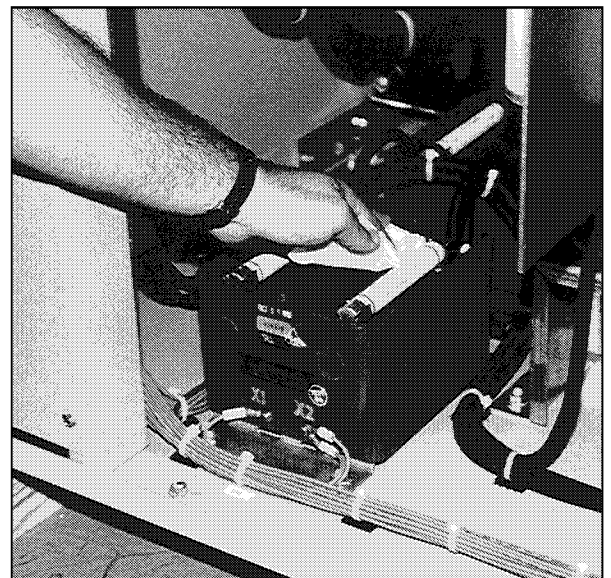


**CONTROL POWER TRANSFORMER**

- Wipe off the surface of the primary fuses mounting plate (Fig. 58), and the control power transformer(optional), (Fig. 59).
- Check the condition of the primary fuses and fuse clips. Check all screws for tightness.



**Fig. 58 Inspect Primary Fuses Mounting Plate**



**Fig. 59 Inspect Control Power Transformer (Optional)**



The following covers procedures to return to service a medium voltage controller which has been required to interrupt a load side short-circuit or ground fault. These procedures are not intended to cover devices such as wiring and motors, which may also require attention.

In an installation which has been properly coordinated and in service prior to a fault, the opening of the current-limiting power fuses in the controller indicates a fault condition in excess of operating overload. This fault condition must be corrected and necessary repairs made to the load circuit before re-energizing the controller.

The following inspection and repair procedures should be carried out by qualified personnel.

## **WARNING**

**Hazardous Voltage. Turn off and lock out Primary and Control Circuit Power before any inspection or testing.**

## **ENCLOSURE**

Check the condition of the enclosure for any signs of bowing or deformation. Check the condition of the doors and latches for damage.

If substantial damage has occurred to the enclosure, such as deformation, displacement of parts or burning, this indicates a problem within the controller which requires major reconditioning or complete replacement of the controller. In this event, contact the nearest Toshiba representative.

## **ISOLATION SWITCH**

The external operating handle must be capable of opening the switch. If the handle fails to open the switch or if visual inspection after opening indicates deterioration beyond

normal wear and tear such as overheating or pitting of blades, insulation breakage or charring, contact your Toshiba representative.

## **POWER FUSE CARTRIDGE**

Check the condition of the power fuse clips, mounting hardware, bus stabs and insulating bases. Any deterioration of these components requires replacement of the damaged parts.

## **TERMINALS AND INTERNAL CONDUCTORS**

Indication of arcing damage or overheating, or both, such as discoloration and melting of insulation, requires replacement of the damaged parts.

## **OVERLOAD RELAYS**

The overload relay must be checked to verify that it will still trip properly. Follow the test instructions provided with the overload device for verifying trip characteristics.

## **VACUUM CONTACTOR**

Operate the vacuum contactor electrically from test power and observe that it opens and closes freely. If the vacuum bottles show any signs of binding, they should be replaced. Contact your Toshiba representative. Check for any signs of arcing damage to the insulated housing.

## **RETURN TO SERVICE**

Before returning the controller to service, repeat the procedure outlined in the PRE-ENERGIZATION CHECK section of this manual.



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